INTERAVIA

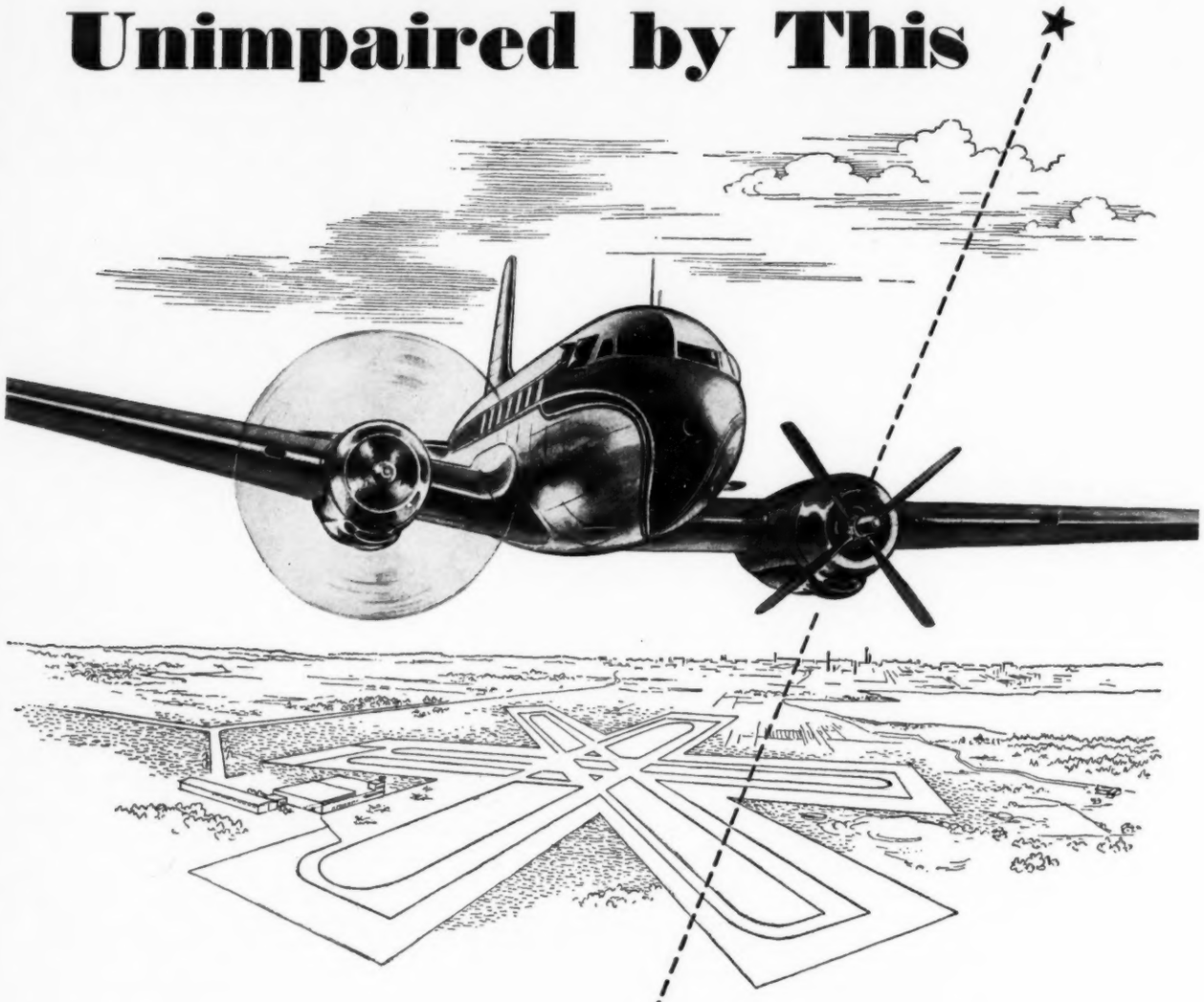
REVIEW OF WORLD AVIATION

IN THIS ISSUE:

United States Air Force

VOLUME V 1-2 1950

Flight stability Unimpaired by This



SINGLE ENGINE PERFORMANCE:

Service Ceiling, Max. Continuous Power, Weight 33,500 lbs	11,150 ft
(R/c = 0.02. V_{so}^2 ft/min)	
Rate of Climb, Max. Continuous Power, Weight 33,500 lbs	
Sea Level	360 ft/min
5,000 ft Altitude	300 ft/min
Min. Runway Length, required by CAR	
Take-off, Sea Level, Weight 35,000 lbs	3,986 ft
Landing, Sea Level, Weight 34,400 lbs	3,180 ft

Even if one engine becomes inoperative, the Scandia's stability and manœuvrability remain unimpaired. In fact, the plane's single engine performance puts it in a class by itself. All pilots who have flown the Scandia are unanimous in praise of its remarkable flight characteristics.

Scandia

SVENSKA AEROPLAN AKTIEBOLAGET · SAAB AIRCRAFT COMPANY · SWEDEN

INTERAVIA

Review of World Aviation

Volume V 1950 No 1-2

Board of Directors : Marcel Devaud, Edgar Primault, Eugen Groh, E. E. Heiman, O. H. C. Messner, E. V. D. Wight, Jr.

Editors : E. E. Heiman. E. de Tavel, E. Herzfeld, P. A. Blackburn.

Assistant Editors : A. de Rham, J. Jenni, A. Arbex, E. Baur.

Art Editor : H. W. Mahrer. **Production :** G. Hirschi.

Publishers and Distributors : Interavia S. A. **Proprietors :** Volamecum S. A.

Contents

The Strategy of the U. S. Air Force		**16**
Air Force Trains "Super-Navigators"		**26**
Air Force Engages in Ten Fields of Research		**28**
Death Gets a Bronx Cheer	SCHOLER BANGS	**29**
U.S.A.F. Researchers Play with Models		**34**
To-morrow's Infantryman Depends on Air Force		**36**
College Students Form Reserve Officers' Pool		**38**
Food is My Favourite Dish		**39**
Air Force Keeps in Touch with Taxpayers		**44**
Sunshine and Cloud in U.S. Air Transportation		**46**
Payload Factor 105		**49**
Surveying by Air	JOHN W. R. TAYLOR	**50**
Wilful Misconduct and the Warsaw Convention	ALAN GOODFELLOW	**55**
"Globemaster II"		**57**
Progress in Pictures		**58**
Selling a Transport Aircraft		**60**
How to Advertise a Transport Aircraft	GENE GACH	**62**
What's in the Air ?		**66**
The British Aircraft Industry : Handley Page	C. G. GREY	**68**
English Electric "Canberra"	JAMES HAY STEVENS	**71**
The Helicopter Goes Farming	PIERRE LEFORT	**75**
Aerodynamic Forces on the Parachute	W. SEIBOLD	**80**
Turbojet Intake Configurations	A. W. QUICK	**82**

Front cover :

Boeing B-50D "Superfortress" Bomber with two 700-gallon external fuel tanks.

Appears Monthly in Four Editions : English, French, Spanish and German.

Advertising Department, Publishing and Editorial Offices, Subscription Department : Interavia S.A., 6, Corraterie, Geneva. Telephone : 5 42 34 (five lines). Cables and Telegrams : Interavia-Geneva.

Annual Subscriptions : Switzerland, Sw. frs. 24.00; U.S.A. and Canada, U.S. $6.00; Great Britain. £ 2 0s 0d: France, Fr. frs. 2,000; Belgium, Belg. frs. 320.00; Holland, Fl. 26.40; Germany, DM 25.00; Sweden, Kr. 30.00; Norway, Kr. 40.00. All other countries : Sw. frs. 24.00.

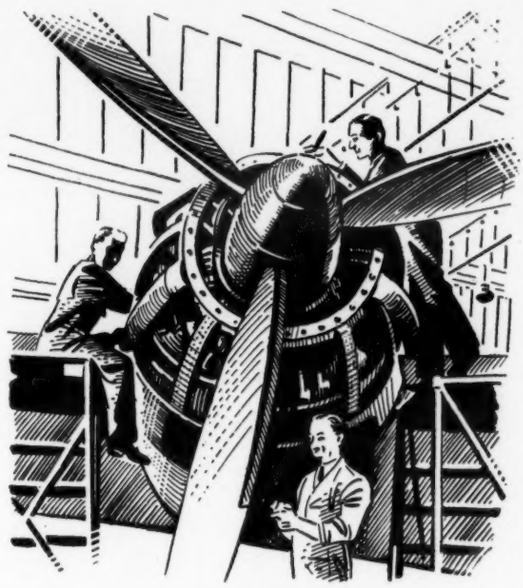
Agents and Distributing Offices :

INTERAVIA ARGENTINA :	Circulo de Aeronáutico : Casilla Correo 4988, Correo Central, Buenos Aires.
INTERAVIA BELGIUM :	11 Rue de Crayer, Brussels, or Office de Publicité, 16 rue Marcq, Brussels.
INTERAVIA BRAZIL :	R. F. Besnard, 91 av. Almirante Barroso, S. 417-419, Rio de Janeiro.
INTERAVIA DENMARK :	Dansk Centralagentur, Stormgade 20, Copenhagen.
INTERAVIA FRANCE :	144, Champs-Elysées, Paris VIII^e^.
INTERAVIA GERMANY :	Ausland-Zeitungshandel W. E. Saarbach, Frankenstrasse 14, Cologne-Junkersdorf.
INTERAVIA GREAT BRITAIN :	Interavia (United Kingdom) Ltd., Standbrook House, 2-5, Old Bond Street, London, W. 1.
INTERAVIA HOLLAND :	Diepenheim (O.) Warmelo S. 13. M. van Gelderen & Zn., Postbox 826, Amsterdam-C.
INTERAVIA HUNGARY :	Obusz, Akademia-utca, 10, Budapest, V.
INTERAVIA ITALY :	39 Viale di Villa Massimo, Rome.
INTERAVIA SOUTH AFRICA	P. O. Box 6073, Johannesburg.
INTERAVIA SWEDEN :	Postbox 29, Linköping.
INTERAVIA U. S. A. :	155 East 44th Street, Room 2903, New York 17, N. Y. Subscriptions also from the International News Co. 131 Varick Street, New York, N. Y.

Copyright 1950 by Interavia S. A., Geneva, Switzerland

Printed in Switzerland

Imprimeries Populaires, Geneva — Héliographia S. A., Lausanne
Spanish edition : Guillermo Kraft Ltda, Buenos Aires



◆ **Ceaseless testing...**

◆ **Minute accuracy...**

◆ **First grade equipment...**

maintained from the very first day the company was founded, form the backbone of K.L.M.'s operational reliability.
Add thirty years of experience acquired along the air routes of the world, and personnel pledged to extra service, and you get the sum total of the seasoned air traveller's preference for the high standard of performance of the world's *first* airline.

7 GREAT SERVICES :

1. **Transatlantic**
2. **Europe**
3. **Middle and Far East**
4. **West Indies**
5. **South America**
6. **South Africa**
7. **Indonesia**

KLM

PHOTO SCHALL

1950

These figures illustrate the performance of

AIR FRANCE

	1938	1946	1947	1948	1949
Aircraft miles.....	6,757,350	14,693,200	19,781,800	23,286,500	25,000,000
Passengers carried.....	104,424	297,314	423,115	573,472	750,000
Mail carried (lbs.)	1,943,840	9,250,200	10,463,800	11,830,900	13,350,000
Freight & express carried (lbs.)	3,016,300	11,216,400	16,332,600	33,794,000	53,000,000

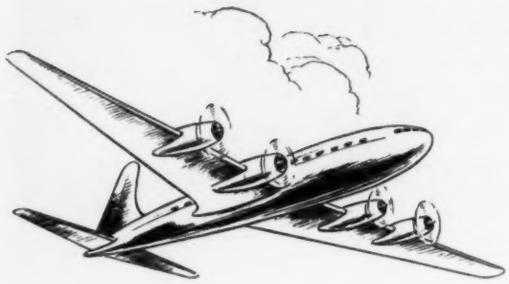
Air France has come a long way since its foundation in 1933. Symbolic of the wide appreciation of its achievements is the award to it, on January 15th, 1950, of the Grand Medal of the Kuhlmann Foundation. The company's growing success has not been accidental: it is solidly based on the trail-blazing work performed by men of the calibre of a Mermoz, of a Guillaumet, of a Saint-Exupery and many others. The spirit which relentlessly drove these pioneers on their chosen path continues to animate Air France's entire personnel. It is this *Esprit de Ligne* of the veterans which has incessantly fired the imagination of their successors and their will to succeed. It took the wealth of experience, the courage and the resourcefulness, the consistency and the staying power, the professional conscientiousness and the faith of this team of men to raise Air France's technical and commercial organization to the high level of perfection indispensable for the operation of the world's most far-flung airways system.

More than anything else it took the typical Air France atmosphere which envelopes the passenger as soon as he steps on board—this exclusive atmosphere he will encounter only aboard Air France's airliners. He steps right into a piece of France, the country where, as the whole world knows, life is a pleasurable thing.

Air France takes great care in the choice of its air hostesses to make sure that they will surround you with the solicitude you would expect from the mistress of one of France's wellkept homes.

Air France's march along the road of progress is evidenced also by the constant modernization and replacement of its air fleet, and by the meticulous care devoted to its maintenance. After each 1,000 hours of flying time every item of equipment is replaced by a new instrument or component. Finally, this forward march is demonstrated by the fact that over the past ten years the amount of freight and express carried by the company has increased 1,750 per cent.

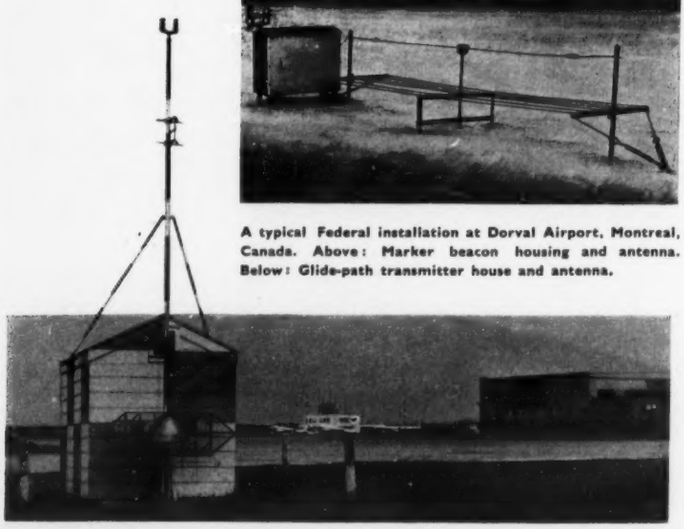
Air France employs the country's best "chefs de cuisine" to prepare the most delicious meals, which you are invited to sample on Air France's long-distance services.



NEW STANDARDS OF SCHEDULED FLIGHT COMPLETION *in CANADA*

★ FEDERAL ILS

at 7 major airports permits increased operations under adverse weather



A typical Federal installation at Dorval Airport, Montreal, Canada. Above: Marker beacon housing and antenna. Below: Glide-path transmitter house and antenna.

FEDERAL INSTRUMENT LANDING SYSTEMS are on duty at seven of Canada's key airports, providing air traffic with a dependable vital link in maintaining schedules, even under conditions of poor visibility and low ceiling.

Our northern neighbor thus takes its place with the U. S. as a leader among the nations where Federal Instrument Landing Equipment is in operation or being installed... an imposing list that includes Belgium, Sweden, France, Denmark, Switzerland, Holland, Ireland, Portugal, Argentina, Italy and Lebanon.

Federal leadership in ILS dates back to the experimental Indianapolis installation in 1937. In the ensuing years Federal collaborated with the CAA in the development and manufacture of ILS Equipment. During the war Federal ILS was adopted as standard by the U.S. Armed Forces for operation throughout the world.

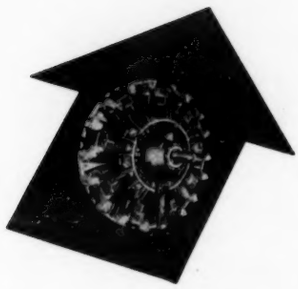
Today, Federal "all-in-one-package" Instrument Landing Systems are available for installation and operation anywhere in the world. They feature the many important improvements that have resulted from Federal's pre-war, wartime and post-war design and production experience.

Contact your local International Standard Electric Corporation office for complete details.

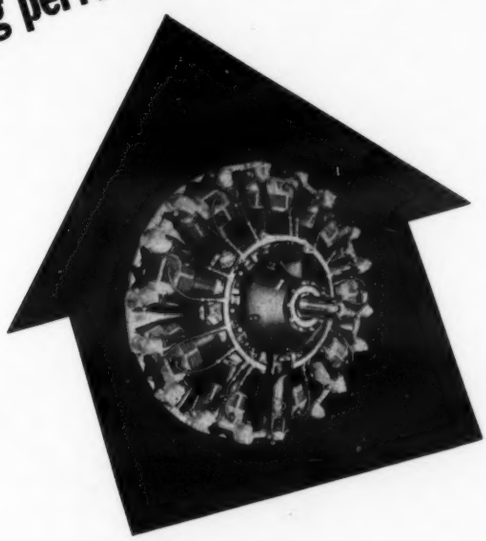
FEDERAL TELEPHONE & RADIO — FTR — An IT&T Associate

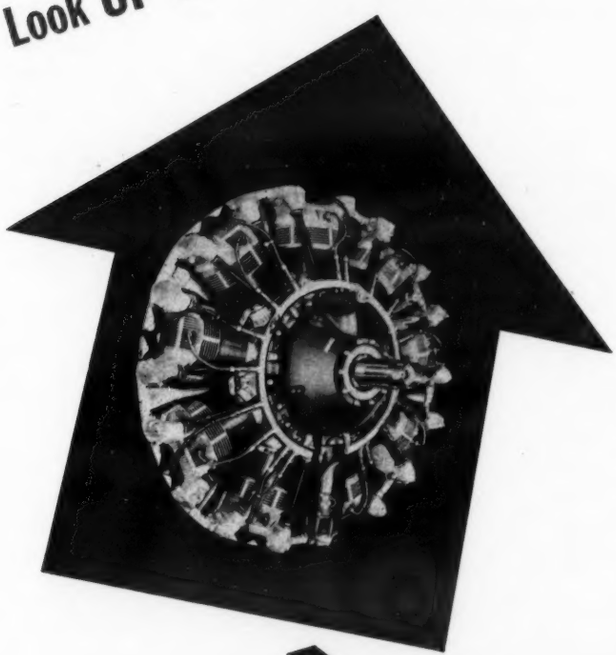
Federal Telephone and Radio Corporation

100 KINGSLAND ROAD, CLIFTON, NEW JERSEY, U.S.A.
In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., N.Y.



Look UP to the Cyclone 9HE . . . for operating performance and economy





- More than twenty years of intensive power development and weight reduction have brought the Wright Cyclone to the standard of performance and operating economy represented by the Cyclone 9HE—heart of the Super DC-3. This means commercial air transports powered by the Cyclone 9HE go faster, farther, carry more payload at less cost.

Up and away fast. The Cyclone 9HE's take-off rating is 1475 horsepower.

Farther on less fuel. Better fuel distribution reduces fuel consumption and cost and increases range.

Less weight — more payload. Today's Cyclone 9 weighs 1390 pounds —less than one pound per horsepower. Result... bigger payloads.

More time in the air... less time on the ground. Steel crankcase, forged aluminium cylinder heads and other construction refinements cut maintenance and overhaul time, increase service life. Long periods between overhauls have already been established.

50% less cooling drag. Improved cylinder cooling characteristics have reduced cooling drag horsepower—thereby improving airplane performance. Another boost to economical operation.

NOW... as *power plant* of the swift new Douglas Super DC-3... the Wright Cyclone 9HE is showing exceptional capacity to *raise* commercial air transport to new standards of operation while *lowering* operating costs to new per passenger-mile minimums.

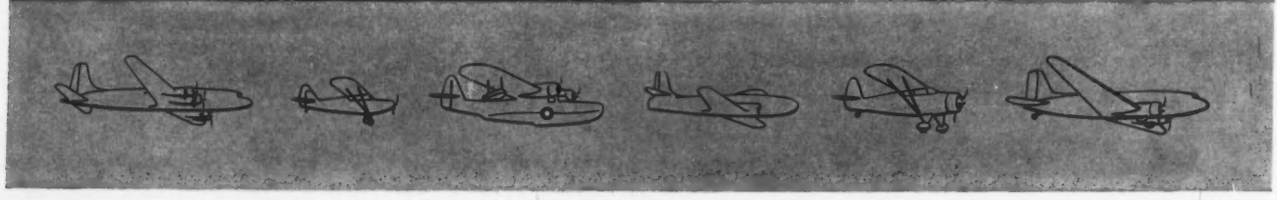
A DIVISION OF CURTISS WRIGHT FIRST IN FLIGHT

WRIGHT

WRIGHT AERONAUTICAL CORPORATION · WOOD-RIDGE, NEW JERSEY, U. S. A.

Wherever Bendix is there to serve

Henry W. Peabody & Cia. Buenos Aires Argentina	"REMMA" S. A. Rio de Janeiro Brazil	Scintex Courbevoie, Seine France	C.I.E.R. Rome Italy	Brown & Dureau Limited Wellington C1 New Zealand	Siamses Airways Co. Ltd. Bangkok Siam	Marten Stenhardt Stockholm, Sweden
						AB Bil-Aero Electric Stockholm, Sweden
Tecnico Limited Marrickville, N.S.W. Australia	Lutz, Ferrando Rio de Janeiro Brazil	K. Karayannis & Co. Athens Greece	Nardi Milan Italy	Thor Solberg Aviation Oslo Norway	Taeuber & Corssen Capetown South Africa	Mr. Christian Beusch Zurich, Switzerland
Electronic Industries Melbourne, Australia	Osoria & Cia Ltda. Santiago Chile	Grote & Co. Athens Greece	Automotriz O'Farrill, S.A. Mexico, D.F. Mexico	Radio Pacifico Panama City Panama	C.W. Price & Co. Ltd. Johannesburg South Africa	Refah AYBER & Cie Istanbul Turkey
Intair Antwerp, Belgium	Wilkie & Cia., Ltda. Bogota Colombia	Auto & Aero Corp. Ltd., Bangalore India	Horr & Choperena Sucr. Mexico, D.F. Mexico	Compania de Aviacion "Faucett" Lima, Peru	Dowson & Dobson Ltd. Johannesburg South Africa	Pike & Co. Ltd. Montevideo Uruguay
Genimex Brussels, Belgium						
Intair Leopoldville Belgian Congo	Danavia Copenhagen Denmark	Kalse Swede Co. Ltd. Tehran Iran	Hollinda The Hague Netherlands	G. Santos Lourenco Marques Portuguese East Africa	Iberavia Madrid Spain	C. Adrianza & Cia., S.A. Caracas Venezuela



you are...

you!

The huge, world-wide distributing organization of Bendix International has only one purpose — to serve you, wherever you may be. Thus, Bendix International affords you the advantages of *one* source of supply for all the major aircraft components, with a large stock near you — available at all times. When special shipments are required, trained personnel handle all of the problems of paper work and export licenses, assuring rapid deliveries and efficient service. From the moment you place the original order with your local distributor, you will agree — it is always *easy* to do business with Bendix International.

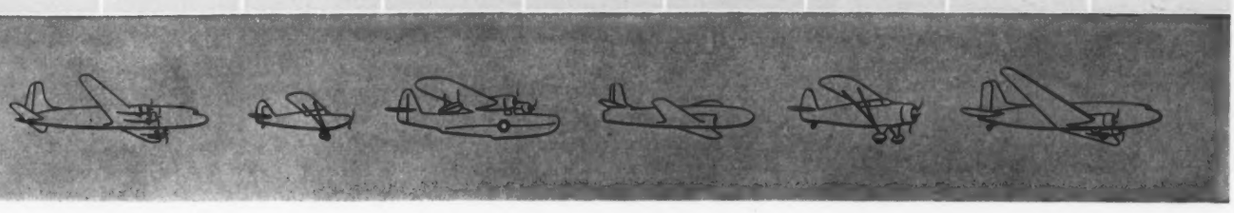
BENDIX INTERNATIONAL DIVISION of
72 Fifth Avenue · New York 11, N. Y.

Bendix
AVIATION CORPORATION

Choose Bendix for All Major Aircraft Components

Stromberg* Injection Carburetors · Bendix* Direct Injection Systems · Bendix* Fuel Metering Systems · Bendix Shock Absorbing Struts · Bendix Airplane Wheels and Brakes · Bendix* Hydraulic Equipment · Pioneer* Flight Control Instruments · Eclipse* Engine Components · Bendix* Air and Ground Communication Radio · Bendix* Flightweight Radio · Skinner Aviation Fuel Filters · Bendix-Scintilla Magnetos and Ignition Equipment · Bendix Radar Equipment · Friez Meteorological Instruments · Bendix Dynamotors · Eclipse* Metal Hose · Bendix* Mobile Radio · Bendix* Metalclene · Bendix-Pacific Timers and Actuators.

* REG. U.S. PAT. OFF.



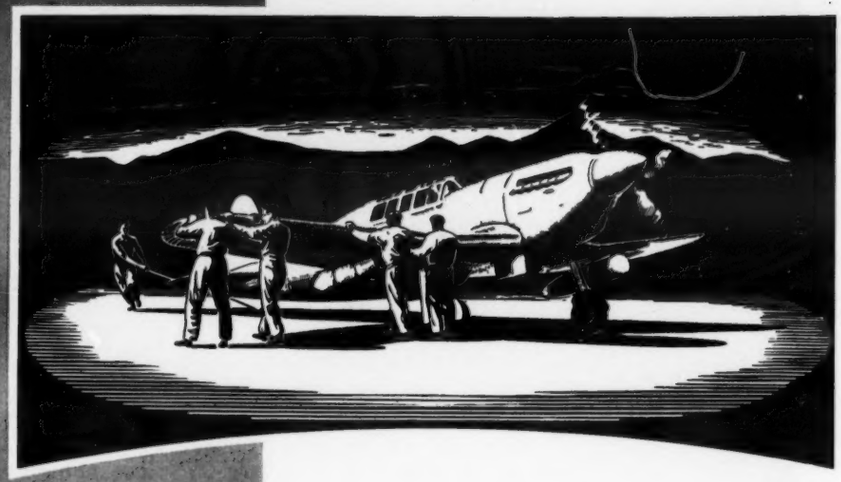
GENEVA

VACATION CITY - EXCURSION CENTRE - SPORTS EVENTS
PARKS - PROMENADES - ORGANIZED EVENTS AND SHOWS
OF EVERY KIND - CONCERTS - AMUSEMENTS - THEATRES

CENTRE OF THE FINE ARTS, OF SPIRITUAL AND
AESTHETICAL LIFE - MUSEUMS - UNIVERSITY
HISTORICAL SHRINES - MONUMENTS

SEAT OF THE INTERNATIONAL INSTITUTIONS

FOR DETAILED INFORMATION AND LITERATURE APPLY TO:
ASSOCIATION DES INTÉRÊTS DE GENÈVE (TOURIST OFFICE)
3, PLACE DES BERGUES - GENEVA - SWITZERLAND



The New

"FIAT G.59"

High-Speed Trainer

The G. 59 is a modern fighter-trainer, developed as a single-seater and as a two-seater. It is designed to fulfill missions requiring speed and manœuvrability, combined with high rates of climb. Its easy handling characteristics make it the ideal type for basic and advanced training. It is particularly suitable for the training of pilots at top speeds, at great altitudes and in acrobatic flying.

Its unusual robustness allows a pilot—from the point of view of structural strength—to perform even the most hazardous manœuvres with the greatest degree of security. It is fitted with the latest instruments and equipment and reaches a maximum speed of 370 miles per hour (600 km/h) in level flight.

Efficient in business

faithful to

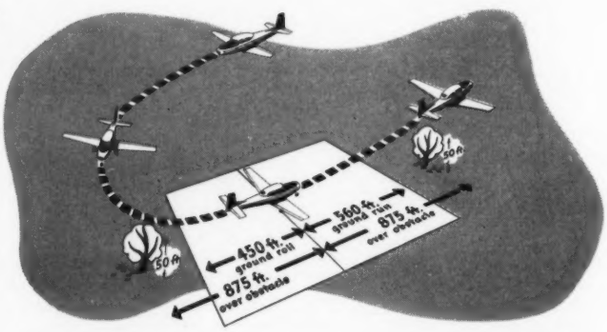
DOXA

The high-class watch

LE LOCLE
SUISSE
1889

RYAN NAVION...
EASIEST TO FLY AND LAND

The 155 mph., all-metal RYAN NAVION gives maximum safety and ease of operation even from roughest, improvised fields... plus all-purpose cargo and passenger utility. Inter-connected aileron and rudder control, stall-resistant wing — plus many other features — give smooth, easy flying, even in rough air. *Navion's* sound-insulated, ventilated cabin accomodates four people plus 180 lbs. of luggage. Quickly removable seats mean you can fly 590 lbs. of cargo... and the exclusive canopy is removable for easy bulk loading. Optional auxiliary tank increases range to 800 miles. Two-way radio with dome speaker is standard equipment. Write to distributors listed below for demonstration and complete information.



SHORTEST, SLOWEST LANDING ... of any plane in its class. Here are the unmatched reasons why: full-deflection flaps; 360° visibility; sturdiest tricycle landing gear; high ground clearance; over-size tires; wide-wheel tread; extra powerful hydraulic shock absorbers and brakes; *steerable* nosewheel. Variable-pitch propeller and 205 hp. engine give fast, sharp takeoffs — even with maximum loads and at high altitude airports.

27 YEARS OF RYAN ENGINEERING and production experience go into the ruggedly built *Navion*, assuring minimum maintenance. No wonder thousands of owners are saying *Ryan Navion* is the *better, more useful* 4-place plane.

Ryan Navion

RYAN AERONAUTICAL COMPANY, SAN DIEGO 12, CALIFORNIA, U.S.A.
Cable address: RYANCO, SAN DIEGO

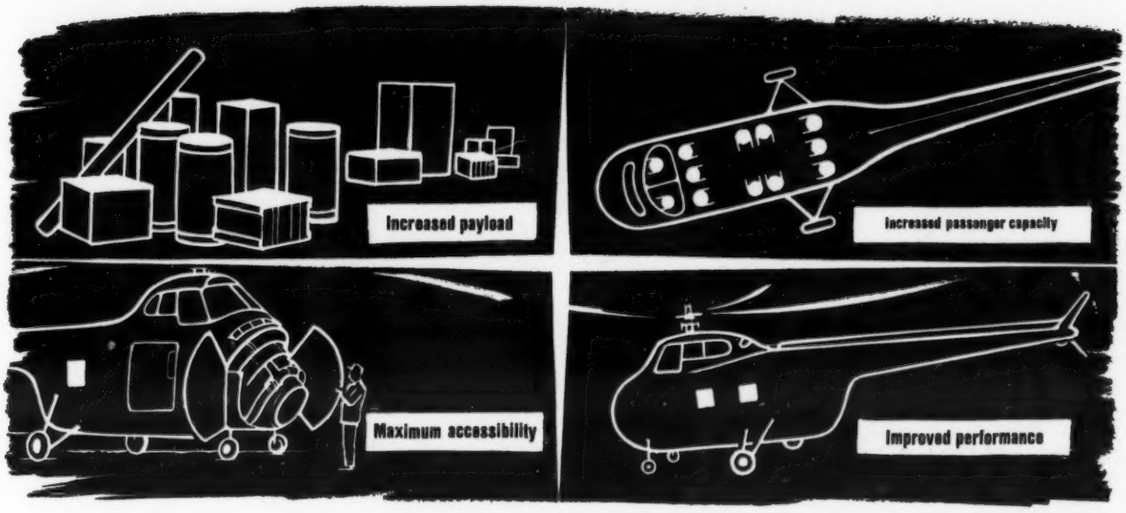
FRANCE: ANCO, INC.
22, rue Georges Bizet
PARIS 16, (FRANCE)

CANADA: CHINOOK FLYING SERVICE, LTD.
Municipal Airport
CALGARY, ALBERTA, CANADA

SOUTH AFRICA: PRETORIA LIGHT AIRCRAFT CO. (PTY) LTD.
Wonderboom Airport, P.O Box 1027
PRETORIA, UNION OF SOUTH AFRICA

Announcing a

NEW
SIKORSKY HELICOPTER



the S-55

Sikorsky Aircraft announces the acceptance of its new 12-place helicopter by the United States Air Force.

The commercial version of this aircraft, designated the S-55, carries more than twice the payload of previous models. This latest Sikorsky helicopter combines many important advances in performance, dependability, maintenance and ease of handling on the ground and in the air.

UNITED AIRCRAFT
Export Corporation
EAST HARTFORD, CONNECTICUT, U.S.A.

European Office : 4 rue Montagne-du-Parc, Brussels, Belgium

PRATT & WHITNEY	HAMILTON STANDARD	CHANCE VOUGHT	SIKORSKY
ENGINES	PROPELLERS	AIRPLANES	HELICOPTERS

The Lockheed Constellation

NO OTHER TRANSPORT RE-ORDERED SO OFTEN

The Lockheed Constellation is the world's most re-ordered four-engined transport. Most of the 14 major world operators that have purchased Constellations have re-ordered this luxury airliner again and again, some as often as six times. Such repeat orders prove that Constellation customers are satisfied customers. "*The proof of the pudding is in the eating!*" Most recent purchaser of Constellations is the Chicago & Southern Air Lines, which recently bought five Constellations. In 1949 alone, five major world airlines ordered a total of 41 new Constellations.

The dependable, profitable operation of Constellations over more than 5,000 *million* passenger miles, including nearly 20,000 Atlantic crossings, constitutes a *tried and proven* record that has created orders and re-orders. The constant world-wide demand has kept the Lockheed Constellation production line in continuous operation.

Look to Lockheed for Leadership—

LOCKHEED AIRCRAFT CORPORATION
BURBANK, CALIFORNIA, U.S.A.

To our readers—

This number of "Interavia, Review of World Aviation," appears as a double issue. It bears the designation "Volume V, No. 1-2, 1950."

While the greatly enlarged editorial content and the new aspect of the magazine alone may justify this title, we nevertheless wish to inform you of the reasons which have induced us to take this temporary measure.

You will readily imagine what it means to produce a specialized magazine of international significance in four separate language editions, English, French, Spanish and German. It means, in effect, that four individual magazines must be edited, set up and printed. It means that a staff of editorial and commercial collaborators must be organized in a large number of countries, a staff which has to be expanded continuously if it is to perform its proper functions. It also means that constant care must be taken to prevent day-to-day routine from impairing the vigour and vivacity of the magazine. And all this means that the publication of such an international journal is not an easy task and—last but not least—demands an expenditure of funds incomparably greater than the production of a national aviation magazine in a single language.

This is why last autumn we found ourselves faced by serious difficulties. That we have succeeded in mastering them is largely attributable to the efforts of our collaborators at home and abroad. One major result of these efforts, we believe, will be a return to our original aim, as stated in our inaugural issue—"prodesse et delectare," to be useful and to distract, by giving you a magazine which is lively, instructive and of topical interest. The present double issue, featuring a highly topical subject, may serve as a preliminary sample.

To carry out this reorganization, time was of the essence. Delays in publication became inevitable. It would have been impossible to produce the issue for December, 1949, before the end of the title month, and we reluctantly decided to drop it altogether. We offer our apologies for this brief interruption, which will not recur. In the long run, we are convinced, it will give you no cause for regret. In order to compensate subscribers for the loss of the December issue, all subscriptions then running have been extended by one month. We shall now endeavour to eliminate the present delay over the next few months and, at the same time, to introduce a number of improvements to the magazine.

The numerous messages we received during this period of reorganization have shown us that "Interavia, Review of World Aviation" is much appreciated all over the world. We wish to thank all our readers for their encouragement and interest and shall not fail to justify their confidence.

THE PUBLISHERS AND EDITORS

The Strategy of the United States Air Force

"Intercontinental air warfare of the future can be described by the phrase, 'one airplane, one bomb, one city'," General Carl Andrews Spaatz told the U.S. Air Force Association in New York on January 26th. The General, who commanded the U.S. air forces in Europe during the war and subsequently held office as U.S.A.F. Chief of Staff until the middle of 1948, evidently expressed, in a nutshell, the fundamental thinking of the U.S. air arm. Although he has retired from the Service, there is nobody better qualified to speak for the U.S.A.F. : it was he who guided the post-war evolution of Air Force strategy on the basis of experience gathered in both major theatres of World War II, Europe and the Pacific, and it would be difficult to define this strategy more concisely.

The adoption of the idea of strategic bombardment as the U.S.A.F.'s principal credo is the logical outcome of the last war, during which the Americans, in collaboration with the British, proved that strategic bombing of enemy industrial installations and communications could be an effective means of weakening a nation's will to resist and, above all, its material power of resistance. The Air Force's modern concept of *intercontinental* strategic bombing merely is the result of further advances in the science of aeronautical engineering, which have made possible the production of larger, longer-range bombers, and the advent of the atomic bomb.

In accepting intercontinental air bombardment as a valid strategic concept, the military planners of the U.S.A. have shown the extent to which their thinking has evolved during the past forty years. In 1907 the U.S. War Department initiated a request to Congress for $25,000 to purchase the nation's first military aeroplane. A few years later the Army's Chief of Staff admitted during testimony before a Senate Committee that the flying machine gave considerable promise of becoming "an acceptable supplement to the horse cavalry as a means of reconnaissance." It was not until after World War I that airmen in every part of the globe began to sense the importance of air power in modern war. And today, after two-and-a-half years as an autonomous Service of the U.S. national military establishment co-equal in status with the Army and Navy, the Air Force is bending its strongest efforts towards becoming the world's first true instrument of intercontinental warfare.

This development has not been unexpected. It was predicted at the close of World War II by the late General Henry H. Arnold, wartime chief of United States military air power. He warned that in the event of another armed conflict, American pilots and air crews would find themselves engaged in long-range operations between continents, probably passing over the ice-cap surrounding the North Pole. In this opinion he was strongly seconded by other senior officers of the Air Force, notably by two air strategists who contributed to the defeat of Japan. Lieutenant-General Curtis E. LeMay, present Chief of the Air Force's Strategic Air Command, which would go into action instantly at the outbreak of another war, summarized present policy as follows : "The idea is to build a mobile, long-range striking force carrying atomic weapons and capable of hitting targets anywhere in the world from North American bases." General George C. Kenney, now Commandant of the University of the Air, top strategic school of the Air Force, expressed the same thought with equal clearness. He believes that America's "primary insurance" will be a long-range air striking force "capable of attacking

Formation of Consolidated Vultee B-36 giant bombers. They look small, don't they ?

any target anywhere in the world at almost a moment's notice."

This explains why the Air Force has refused to be turned aside from its intention to create as soon as possible a very long-range heavy bomber force consisting of four groups of huge Consolidated Vultee B-36 bombers, each group comprising 30 aircraft, with an immediate reserve of about 40 bombers. In addition, there will be two groups, again with 30 aircraft each, of Convair RB-36 reconnaissance bombers, plus about 20 aircraft in reserve, making an overall total of about 240 of the big aircraft. It is accepted as fact that this type of aircraft can fly over a combat range well in excess of 4,000 miles, drop its substantial bomb load and return to base. In wartime it would operate at altitudes above 40,000 feet, where enemy fighter opposition is expected to be least effective.

The ambitious plans of the U.S. Air Force to become the spearhead of any offensive action by the U.S. armed forces have given rise to bitter objections from several quarters, notably from the Navy. Criticisms of the Air Force are based on two premises : first, the "atomic blitz" theory itself has been attacked as fallacious ; secondly, the equipment which the Air Force is buying has been decried as unsuitable.

Critics under the first heading insist that the effect of strategic bombing would take a very long time to make itself felt. Despite such bombing, America's only potential enemy, Soviet Russia, could overrun all of Western Europe in a relatively brief period of time. In addition, studies are claimed to have shown that intercontinental strategic bombing would be roughly twice as expensive as bombing from overseas bases, from large aircraft carriers or by special long-range flying-boats. It has been asserted that transoceanic and transarctic raids would pose practically insoluble supply and refuelling problems and that no continuous mass bombardment would be possible. Furthermore, the critics say, bombing from very great altitudes still is highly inaccurate, so that even the long-term effect of strategic bombing is in doubt. The objections are topped off by the assertion that intercontinental bombers cannot establish a beachhead in Europe, and that ultimately, after the expend-

The Boeing B-29 "Superfortress," of Hiroshima and Nagasaki "fame," still forms the major component of the U.S.A.F.'s long-range bomber strength.

Lockheed P-80B "Shooting Star" fighters on the flight line. Some have now been issued to Air National Guard squadrons.

iture of billions on strategic bombing, naval, ground and tactical air forces would still have to undertake the liberation of the European Continent.

The second type of criticism is directed against the equipment which the Air Force is buying to implement its intercontinental air strategy, and notably against the Convair B-36 bomber. The U.S. Navy in fact has called the entire B-36 purchasing programme "a billion-dollar blunder". The U.S. Army's Chief of Staff, General J. Lawton Collins, said in the second week of November that at the present stage of weapons development (B-36) and for the foreseeable future no one Service could possibly wage intercontinental warfare. Admiral Arthur Radford, Commander-in-Chief of the U.S. Pacific Fleet, declared on October 7th, 1949, that the B-36 bomber was "slow, expensive and vulnerable" and that "better aircraft were available to deliver atomic bombs" (probably he was referring to carrier-borne aircraft). He described the type as useless defensively, inadequate offensively and altogether a bad gamble with national security. Other experts claim that procurement of the big bomber was based on a number of "false premises," including the following : radar was ineffective against bombers flying beyond 40,000 ft. ; fighter pilots had trouble finding attacking bombers and jet fighters lacked the performance to intercept them at altitudes of more than 40,000 ft., no night fighter existed which could intercept such bombers in the dark ; and the B-36 could successfully defend itself. Finally, these critics state that the Russians possess ground-to-air anti-aircraft missiles capable of reaching bombers at heights up to 50,000 feet. German anti-aircraft developments, designed to destroy raiders travelling up to 500 m.p.h. at 65,000 ft., had fallen into Russian hands lock, stock and barrel.

The Convair B-36 giant in production. Two hundred and forty aircraft of this basic type have been ordered. Additional contracts are expected to be placed in the 1950-51 fiscal year.

These charges are emphatically denied by the men controlling the overall policy of the U.S. armed forces in general and the Air Force in particular. General Omar N. Bradley, Chairman of the U.S. Joint Chiefs of Staff, has pointed out that it has long been planned to maintain a "balanced force" composed of ground, naval and air forces. This contention is borne out by the fact that of the defence funds allocated in the 1950 fiscal year (totalling just under $16,000,000,000), 33.6 percent was appropriated to the Army, 32.4 percent to the Navy and 34 percent to the Air Force. The Air Force, in turn, is using only a portion of its share for the establishment of an intercontinental air striking force.

Both General Hoyt S. Vandenberg, Air Force Chief of Staff, and W. Stuart Symington, Secretary of the Air Force, have made it clear that they do not regard the B-36 as the only aircraft that can conceivably be built to carry out their air strategy. They have stressed that they do not consider the B-36 the last word in bomber design. But they do believe it to be by far the best product available right now for the job of very long-range bombardment on short notice. Its reported replacement, the all-jet Boeing B-52 bomber, will not be ready for combat until 1952 or 1953. *

Meanwhile, the Air Force also has taken effective steps to extend the range of many of its existing heavy bomber types by adding equipment for refuelling in the air. The efficiency of this aerial refuelling technique was demonstrated in the middle of 1949 by the non-stop round the world flight—the first in aviation history—of the Air Force's Boeing B-50 bomber "Lucky Lady." Sir Alan Cobham, the British airman, whose Flight Refuelling Ltd. supplied large amounts of aerial refuelling equipment to the U.S.A.F., has now applied the same technique to jet fighters. If a way to send Air Force high-performance penetration fighters on long-range missions

* Latest reports state that the B-52 is to be abandoned.

(Turn to page 20)

Latest standard single-seater fighter of the U.S.A.F. is the single-jet swept-wing North American Aviation F-86 "Sabre." Top speed is about 650 m.p.h.

The U.S.A.F.'s first jet fighter was the Lockheed F-80 "Shooting Star," large numbers of which are in service. Some are now used as advanced trainers.

Third single-seater single-jet fighter in squadron service is the Republic F-84 "Thunderjet." Some Air National Guard squadrons are now equipped with it. Numbers of them have been adopted for fighter bombing, as shown by this "flying Christmas tree," a F-84E. It carries 32 five-inch rockets, in addition to six-50-in. cal. machine-guns.

Standard long-range and night fighter is the twin-engined North American P-82 "Twin Mustang." Combat range is over 2,500 miles, top speed more than 475 m.p.h.

Light-medium bomber in service with the U.S.A.F. is the four-jet North American B-45 "Tornado." Top speed is about 530 m.p.h.

New jet-powered medium bomber is the six-engined Boeing B-47 "Stratojet." Maximum speed is 630 m.p.h., gross weight 125,000 lbs.

The piston-engined Boeing B-50 "Superfortress" and its immediate predecessor, the B-29, are still the backbone of the U.S.A.F.'s long-range striking arm, pending delivery of larger numbers of Convair B-36 giant bombers (see box). Now classed as a medium bomber, the B-50A has a gross weight of "only" 140,000 lbs., which has been increased in later versions, such as the B-50D *(above)*.

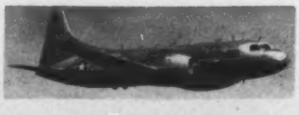
To supplement the fleet of Douglas C-54 "Skymasters", newer C-74 "Globemasters" and smaller types of the Military Air Transport Service, the U.S.A.F. has ordered two types of large transport aircraft, the Boeing C-97 "Stratofreighter" and the huge Douglas C-124 "Globemaster II." Picture shows a number of "Stratofreighters" being readied for delivery. Each of them can carry about 41,000 lbs. of cargo.

Newest U.S.A.F. troop and cargo transports is the Douglas C-124 "Globemaster II," the prototype of which was completed several months ago. Twenty-nine more are on order. Design gross weight is 175,000 lbs.

The U.S.A.F.'s troop and cargo transport "workhorse" is the Fairchild C-119 "Packet," successor to the earlier C-82 "Packet." It can haul up to 10 tons of cargo.

Another type of transport, the three-engined Northrop C-125 "Raider" has been developed especially to carry supplies to forward combat areas. It is simple, rugged, needs little maintenance. Twenty-three have been ordered by the U.S.A.F.

Newest U.S.A.F. trainer is the Consolidated Vultee T-29, a military adaptation of the "Convair-Liner" civil transport. The T-29 is designed as a navigational trainer, enables 14 students and instructors to fly together. The aircraft has four astrodomes on top, plus a large radome housing radar equipment beneath the fuselage forward of the wing. Thirty-six T-29's have been ordered.



The Republic XF-91 is the U.S.A.F.'s first jet fighter designed specifically for high-speed interception of bombers for local defence. Significant characteristics are the inverse wing taper, as well as the four rockets in the tail supplementing the thrust of the gas turbine engine for bursts of high speed. Span is 31 ft., length 49 ft.

USAF

How Strong is the U.S.A.F.?

At the beginning of 1949, the United States Air Force had an active combat aircraft strength of about 5,500 aircraft, with 7,500 additionalt aircraft of non-combat types assigned to "active utility." There were about 11,000 aircraft of both combat and utility types in an inactive reserve stored at various depots throughout the United States. With the 1950 fiscal year appropriations the first-line combat strength originally was to be brought up to 9,200 aircraft by the middle of the current year.

However, in his budget message for the 1950-51 fiscal year, beginning July 1st, 1950, President Truman merely asked sufficient funds to provide for a regular Air Force strength of only 8,800 aircraft, organized in 48 groups and 13 separate squadrons; this would be backed by an Air National Guard of 27 groups and reserve forces of 25 base wings, totalling 3,400 aircraft. This would make an immediately available combat strength of 12,200 aircraft, apart from reserve aircraft in "cold storage."

Deliveries of new aircraft during the 1951 fiscal year are scheduled to total 1,800, compared with 1,400 in the current fiscal year. Including the 1951 budget requests for new aircraft, the Defence Department will have on July 1st, 1950, total unexpended contract *authorizations* for undelivered aircraft of $5,300,000,000 (including Air Force and Navy aircraft procurement). Thus, quite apart from new money to be voted in the 1952 and subsequent fiscal years, the Air Force will have quite a tidy sum for new aircraft as soon as the cash *appropriations* are available.

Man power strength of the Air Force is to be increased to 412,000 officers and men by the end of the 1950 fiscal year. In addition, there will be 45,000 men in the Air National Guard and 68,000 on the Air Force Reserve.

The *planned combat strength* of the U.S. Air Force does not seem to have been finally determined yet. At the end of 1948 the U.S. Secretary of the Air Force, W. Stewart Symington, succeeded in pushing a Bill through Congress fixing the *authorized* Air Force establishment at 70 groups (with an average of about three squadrons each). This does not mean that this strength will ever be attained in peace-time. A year ago, in February, 1949, the Air Force's actual strength was as follows:

	Number of Groups:		
	U.S.A.	*Over-seas*	*Total*
Heavy bombers (1) . .	2	0	2
Medium bombers (2) . .	12	1	13
Light bombers (3) . . .	1	2	3
Day fighters (4)	11	11	22
All-weather fighters (5) .	2	1	3
Tactical reconnaissance (6)	3	1	4
Strategic reconnaissance (7)	3	1	4
Troop carrier (8). . . .	3	6	9
	37	23	60

However, in the course of congressional deliberation on the 1950 Air Force appropriations, President Truman made it known that he wanted an Air Force consisting of 48 groups. Thereupon, the Air Force began a gradual cut in its combat strength. Last August, the Senate adopted legislation providing for this size, but the House of Representatives insisted on a regular Air Force of 57 groups. Senate and House finally got together and decided on 57 groups. But Truman simply withheld the fund necessary to maintain the U.S.A.F. at the proposed strength. At the present time, the Air Force consists of 48 groups plus 13 separate squadrons, as follows:

Heavy bombers (9)	4
Medium bombers	10
Light bombers	1
Day fighters	15
All-weather fighters	5
Tactical reconnaissance	1
Strategic reconnaissance (10)	6
Troop carrier	6
	48

The thirteen separate squadrons are assigned to air-sea rescue, liaison and similar missions.

This composition has been approved by the U.S. Joint Chiefs of Staff—pending the appropriation of funds enabling the Air Force to expand to its present goal of 57 groups.

(1) Convair B-36; (2) Boeing B-29 and B-50 "Superfortress," Boeing B-47 "Stratojet"; (3) North American B-45 "Tornado" jet, North American B-25 "Mitchell," Douglas B-26 "Invader"; (4) Lockheed F-80 "Shooting Star," Republic F-84 "Thunderjet". North American F-86 "Sabre"; (5) North American F-82 "Twin Mustang," Northrop F-61 "Black Widow"; (6) North American "Twin Mustang," Lockheed FP-80 "Shooting Star"; (7) Boeing RB-29 "Superfortress"; (8) Fairchild C-119 and C-82 "Packet"; (9) B-36; (10) two RB-36 groups.

The U.S.A.F.'s newest penetration fighter for bomber escort or long-range fighter-attack missions, the single-engined North American YF-93 *(above)*, made its first flight earlier this year. It is derived from the U.S.A.F.'s standard jet fighter, the North American F-86 "Sabre". Span is 39 ft., length 44 ft. On *below* is the newest version of the "Sabre," the YF-86D, which is not yet in production. Fitted with a more powerful engine and having a new "under-the-nose" air intake, it is intended for high-speed, high-altitude interception. In the background is a North American B-45 "Tornado" four-jet light-medium bomber equipped with wing-tip tanks for longer range.

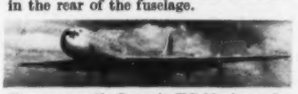
Another penetration fighter, the needle-nosed Lockheed XF-90, is also scheduled for 1950-51 production. It is powered by two 3,000-lbs. jets, has a range of more than 2,000 miles and a ceiling of over 50,000 ft.

The McDonnell XF-88 "Voodoo" twin-jet long-range fighter began its tests early last year. No orders have been placed. It has a design gross weight of 15,000 lbs.

The Northrop XF-89 "Scorpion" is a twin-jet long-range night and all-weather fighter and took to the air towards the end of 1948. Two prototypes were ordered, and production contracts will follow. The XF-89 won first place in an all-weather fighter design competition. Span and length are about 50 ft., gross weight more than 30,000 lbs.

The Lockheed XF-94 single-engined two-seater all-weather fighter is a direct development from the F-80 "Shooting Star." It is equipped with an after-burner.

At the end of last October the U.S.A.F.'s first jet-powered tactical ground-support bomber, the three-engined Martin XB-51, made its initial flight. Wing span is 55 ft. Two engines are under, the third in the rear of the fuselage.



The mammoth Convair XC-99 six-engined troop and cargo transport prototype is now being studied with a view to eventual production. The aircraft is capable of carrying 400 fully equipped troops over 8,000 miles.

The Chase XC-123 is an experimental assault transport capable of carrying 60 fully-armed troops into unprepared landing fields in forward combat areas. The aircraft can be converted into a glider by the removal of engines and nacelles. Useful cargo load is described as "greater than the empty weight of 25,000 lbs."

(Continued from page 18)

as bomber escorts becomes a reality, it will be a strategic achievement of the first magnitude.

The Air Force's accent on range, as well as its choice of the B-36 as the basic striking weapon, is a logical development in keeping with everything done by those charged with the building-up of strategic air power in America during the past two decades.

This long-range concept can be traced directly to the ideas of Major-General Billy Mitchell, America's prophetic airman, and to the writings of the Italian General Giulio Douhet, whose works were translated and distributed in mimeographed form in the early 1930s among officers of the tiny U.S. Army Air Corps. General Mitchell wrote that the underlying principle in the organization of national air power was "the creation

High-velocity aircraft rockets being installed under the wing of a "Thunderjet," standard U.S.A.F. fighter and fighter-bomber.

Last-minute check of the nose gear of a Republic F-84E "Thunderjet" fighter bomber.

of an Air Force capable of the greatest radius of action practical under conditions limited only by personnel, materiel and armament." His Italian counterpart, whose views were even more extreme, asserted: "There is only one attitude that can be adopted in aerial warfare: an intense and violent offensive. We must resign ourselves to the offensive the enemy inflicts on us while striving to put all our resources to work to inflict even heavier offensive blows on him."

Thirty years after it was written, this basic Douhet tenet was repeated almost word for word by General Arnold, who shortly before his death a few weeks ago said that America's best defence "will be to convince other nations that the United States is fully prepared immediately to retaliate with far greater destructive force against any aggressor; that we will answer any unprovoked attack by wholesale destruction."

The idea that such long-range blows against the Eastern Hemisphere can, for the most part, be delivered to best advantage by missions run across the Arctic ice, the shortest route between North America and the heart of the Europe-Asia land mass, has become almost a basic part of present Air Force doctrine. In Air Force language, this in known as the "Polar Concept."

For the past three years, Air Force Boeing B-29 "Superfortress" bombers have been flying routine weather reconnaissance patrols from bases in Alaska to the North Pole and return. A short time ago Colonel Bernt Balchen, the Norwegian-born airman and explorer, who is now on active duty with the U.S.A.F. in Alaska, flew non-stop from Fairbanks, Alaska, to Oslo, Norway, in a Douglas C-54 "Skymaster" to give a hint of the Air Force's theoretical striking power. General Vandenberg, who does not belong to the group of air strategists believing that a war between the United States and the Soviet Union could be won within a few days, has pointed out that because of the possibility of trans-polar bombing, the Arctic regions have a new strategic importance.

This "Polar Concept"—of which the Soviet Union is fully aware (cf. November 1949 issue

(Turn to page 25)

Supplies are loaded into a Fairchild C-82 "Packet" cargo transport.

USAF

The Controversial Instrument

The controversial Consolidated Vultee B-36 ten-engined heavy bomber will be the mainstay of the U.S.A.F.'s strategic air striking force for several years to come. Its heir-apparent, the Boeing B-52, will not come off the production line before 1953.* While some people condemn the policy of intercontinental strategic air bombardment as such, others approve of the policy but claim that the available equipment is not adequate to carry this strategy into effect. But antagonists and protagonists of strategic aerial bombardment agree that the B-36 is the heaviest, longest-ranging, highest-flying and most heavily defended bomber in existence in the world today.

Luckily the big bomber so far has had no chance of giving proof of its capacities under actual combat conditions. However, both manufacturers and Air Force have had a pretty good opportunity of assessing the aircraft's value.

Take the Air Force, for instance. The Seventh Bombardment Wing of the U.S.A.F., with headquarters at Carswell Air Force Base, Fort Worth, Texas, has been operating B-36 bombers for many months. During this time, the Wing has engaged in an intensive training programme to familiarize its air and ground crews with the giant bomber and find out exactly what it would be able to do in the event of war. The B-36s of the Wing have done pretty well so far, as the following feats will show :

Last year a B-36 dropped two 42,000-lb. dummy bombs on a practice mission at Edwards Air Force Base, the U.S.A.F.'s giant experimental station on the Muroc Dry Lake in the Mojave Desert, California. This was the heaviest load ever carried by one aeroplane.

Under simulated combat conditions a B-36 has flown over 6,000 miles at an average speed of more than 300 miles an hour. The longest B-36 flight to date was a 9,600 air-mile non-stop mock bombing mission, and on at least two occasions B-36's have flown at 40,000 ft. or more for longer than 12 hours, believed to be the longest high-altitude missions ever flown.

To follow the average daily activities of a B-36 pilot, let us pick out the case of an average pilot at Carswell Air Force Base. He is Captain Thomas A. Marvin, who hails from Indianapolis, Indiana—though this is of little importance because there are many others like him.

Captain Marvin's morning commences with notification that his crew is to fly the following day.

Next morning, the first step on the agenda is to ascertain that the B-36 is cleared mechanically for the flight. Briefing is the second move, so that each member of the 15-man crew (including a relief crew of four) is familiar with his particular assignment and informed of the characteristics of the mission, including distance, take-off time, weather conditions to be encountered and experimentation data to be gathered (if any). Following briefing, preparation for the flight is made with regard to an important item—food. A complete kitchen and food service is available to flight crews. Packaged meals now in the experimental stage include steaks, chops and all the trimmings. Presently small ovens will be installed in all aircraft, and in a matter of minutes a hot, steaming meal will be available to all crew members. At 40,000 feet, in extreme sub-zero temperature, the men will be able to enjoy a swiss steak, mashed potatoes, diced carrots, bread, butter and coffee. It sounds a little far-fetched, but it's true...

Next move is the pre-flight inspection by pilot, co-pilot and flight engineers. Everything is checked out all right, the crew climb aboard, tower clearance is obtained, taxi instructions are received, and 163 tons of bomber lifts off the runway, nose pointed for destination.

Captain Marvin has been ordered to carry out a "round-robin" mission. The first leg is from Fort Worth, Texas, to Miami, Florida, a distance of 1,100 miles. In something over 3½ hours, Miami is sighted. Non-stop the huge B-36 wings north on leg number two, another 1,100 miles to Cleveland, Ohio. After Cleveland is sighted, the relief crew takes over for the flight northwest to Minneapolis, Minnesota, 650 miles away. While the first crew sleeps in the aft compartment beds, the big bomber reaches its target ; in a wide circle it turns west, then south and southeast and finally noses toward Fort Worth again, flying a distance of 2,050 miles. Twenty-one hours and 4,900 miles after the take-off, the B-36 glides in for the landing at Carswell Air Force Base. All members of the crew, pilots, navigators, engineers, scanners and radio operators, report on operating conditions of their particular responsibility—thus completing another B-36 practice mission.

The Consolidated Vultee B-36

The U.S. Air Force has ordered 170 B-36 bombers to enable the Strategic Air Command to conduct long-range operations any time anywhere in the world. In addition, about 70 RB-36 strategic reconnaissance bombers are on order.

A substantial number of aircraft have already been delivered. Following are the principal characteristics of the type :

Length	162 ft.
Wing span	230 ft.
Height (tail)	46 ft. 9 in.
Power plant	6 P&W "Wasp Major" pushers of 3,500 h.p. each. 4 J-47 jets of 5,000 lbs. thrust each.
Maximum speed (without jets)	over 350 m.p.h.
Service ceiling	45,000 ft.
Design range and bomb load	10,000 miles with 10,000 lbs. of bombs.
Combat radius	over 4,000 miles.
Maximum bomb load	84,000 lbs.
Crew	15 men.
Fuel capacity (without J-47 jets)	21,116 U.S. gals.
Oil capacity (without J-47 jets)	1,200 U.S. gals.
Armament	16 20-mm cannon.

The power developed by the six Pratt & Whitney engines, totalling 21,000 h.p., is roughly equivalent to that of five modern locomotives pulling trains at top speed. A 600-room hotel or 120 five-room houses could be heated with the anti-icing equipment of the B-36. A medium-powered automobile could circle the globe 16 times on the 21,116 gallons of gasoline carried by the aircraft.

The four General Electric J-47 jet engines fitted to a few of the bombers in pods beneath the outer wing panels are an experimental development for the time being, designed to provide additional power for take-off and target area speed.

With regard to armament, the B-36 has more defensive firepower than any other aircraft ever built. It has eight remote-controlled power-operatd turrets containing a total of sixteen 20-mm cannon.

The planning stage of the mammoth aircraft started early in 1941, and it took five years of research, development and experimentation before the prototype, the XB-36, made its first flight in August, 1946. Development of the B-36 has by no means come to an end, as the installation of the General Electric jets demonstrate. This is evident also from the fact that a strategic reconnaissance version of the aircraft has been designed and ordered. At the same time, the U.S.A.F. is conducting test flights with a cargo version of the B-36, the giant XC-99. It is hard to visualize an aircraft which will carry 100,000 lbs. of cargo (over an unspecified range) or 400 fully-equipped troops over 8,000 miles. This means that 100 C-99 transports could carry 40,000 fully-equipped men one-third around the globe... The U.S.A.F.'s experts are at present examining the possibility or advisability of ordering a batch of these enormous transports.

* Development of the B-52 has now been dropped, according to recent U.S.A.F. statements.

USAF

The Brain Behind the Brawn

Like a champion boxer, an air arm which proposes to win in the event of an armed conflict must have not only brawn, but also quite a lot of brain. What good are thousands of aircraft and thousands of men if the planners directing the air force fail in their duty to procure the *right* kind of airplanes in the *right* kind of proportion, give their men proper training, work out a strategy paying off in the shortest possible time, plan attacks on targets which will hurt the enemy most ? In the chart reproduced below, the two top groups represent the brain, or the staff, of the U.S. Air Force. The bottom group marks the brawn, the fist, the physical power to attack and defend, to train and provide for the U.S.A.F.'s needs. Each of the divisions indicated is split into a multitude of divisions and branches.

The Commander-in-Chief of the U.S. armed forces is the President, Harry S. Truman. Responsibility for the defence of the U.S.A. is delegated to the Secretary of Defence, Louis A. Johnson. He controls three military departments of equal status, the Army, Navy and Air Force Departments. The civilian Chief of the Air Force is the Secretary of the Air Force, W. Stuart Symington, who is assisted by one Under-Secretary and two Assistant Secretaries. The U.S.A.F. formerly was a component of the U.S. Army but has been an autonomous component of the U.S. National Military Establishment since the passage of the so-called Unification Act of the armed services in 1947. U.S.A.F. headquarters, like those of the Army and Navy, are located in the huge Pentagon Building, Washington.

The following paragraphs explain the functions of the major air staff divisions responsible to the Chief of Staff of the U.S.A.F. as well as the missions assigned to the most important components of the operational part of the U.S.A.F.

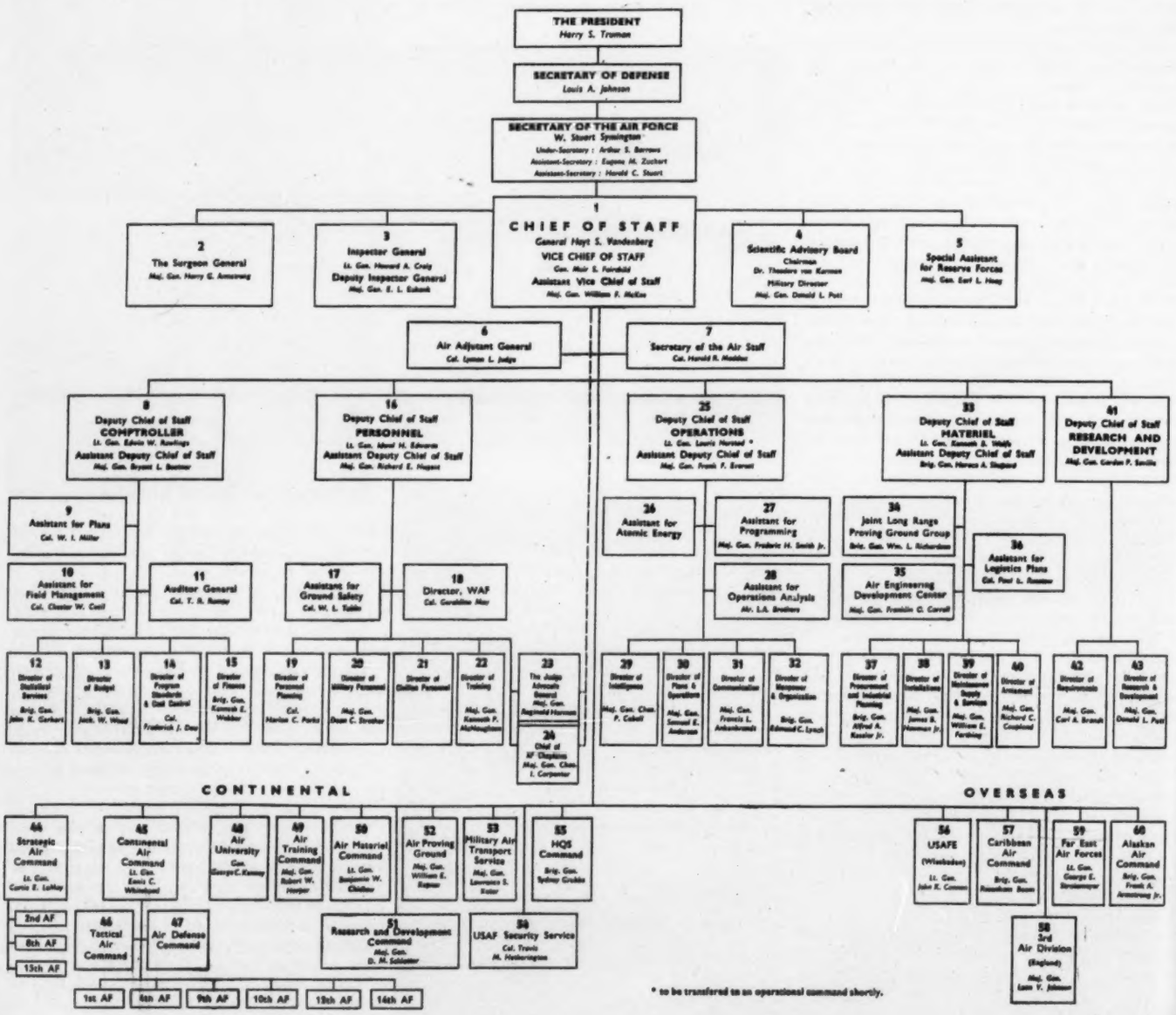
1. The **CHIEF OF STAFF** of the U.S.A.F. is the Commander-in-Chief of the U.S.A.F. and charged with the execution of orders and directions of his civilian superiors. He is responsible for the formulation of policies and Air Force plans. He also serves as a member of the War Council and the Joint Chiefs of Staff of the National Military Establishment. Under him a Vice-Chief, an Assistant Vice-Chief, and five Deputy Chiefs, in addition to a number of special assistants.

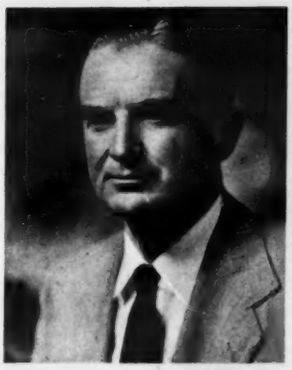
The **Vice-Chief of Staff** acts as the officer through whom the Chief of Staff exercises command over the U.S.A.F. He also serves as Chairman of the U.S.A.F. Aircraft and Weapons Board and the Aeronautical Board and supervises the activities of the Air Staff.

The **Assistant Vice-Chief of Staff** acts as an assistant to the Chief and the Vice-Chief of Staff and exercices general supervision of administrative procedures within the Air Staff.

2. The **SURGEON-GENERAL** is in charge of all medical matters pertaining to the U.S.A.F. His subordinates are the Chief of Dental Services, the Director of Professional Services (medical policies), and two other directors controlling the training of medical personnel and the maintenance of hospitalization facilities.

3. The **INSPECTOR-GENERAL** and the Deputy Inspector-General supervise the combat readiness and logistic effectiveness of the Air Force. Their subordinates include the Air Inspector, who amongst other responsibilities has charge of the Flying Safety Division ; and the Air Provost Marshal, who is the head of U.S. A.F. police and notably takes care of Air Force security measures.


THE PRESIDENT
Harry S. Truman
SECRETARY OF DEFENSE
Louis A. Johnson
SECRETARY OF THE AIR FORCE
W. Stuart Symington
1 CHIEF OF STAFF
General Hoyt S. Vandenberg
VICE CHIEF OF STAFF
Assistant Vice Chief of Staff
2 The Surgeon General
3 Inspector General
Deputy Inspector General
4 Scientific Advisory Board
Chairman
Military Director
5 Special Assistant for Reserve Forces
6 Air Adjutant General
7 Secretary of the Air Staff
8 Deputy Chief of Staff COMPTROLLER
Assistant Deputy Chief of Staff
16 Deputy Chief of Staff PERSONNEL
Assistant Deputy Chief of Staff
25 Deputy Chief of Staff OPERATIONS
Assistant Deputy Chief of Staff
33 Deputy Chief of Staff MATERIEL
Assistant Deputy Chief of Staff
41 Deputy Chief of Staff RESEARCH AND DEVELOPMENT
9 Assistant for Plans
10 Assistant for Field Management
11 Auditor General
17 Assistant for Ground Safety
18 Director, WAF
26 Assistant for Atomic Energy
27 Assistant for Programming
28 Assistant for Operations Analysis
34 Joint Long Range Proving Ground Group
35 Air Engineering Development Center
36 Assistant for Logistics Plans
12 13 14 15 19 20 21 22 23 24
29 30 31 32
37 38 39 40 42 43
CONTINENTAL
OVERSEAS
44 Strategic Air Command
45 Continental Air Command
48 Air University
49 Air Training Command
50 Air Materiel Command
52 Air Proving Ground
53 Military Air Transport Service
55 HQS Command
56 USAFE (Wiesbaden)
57 Caribbean Air Command
59 Far East Air Forces
60 Alaskan Air Command
2nd AF
8th AF
15th AF
46 Tactical Air Command
47 Air Defense Command
51 Research and Development Command
54 USAF Security Service
58 3rd Air Division (England)
1st AF
4th AF
9th AF
10th AF
13th AF
14th AF
* to be transfered to an operational command shortly.



W. Stuart Symington,
Secretary, U.S. Air Force Department

General Hoyt S. Vandenberg,
Air Force Chief of Staff

General Muir S. Fairchild,
Vice-Chief of Staff [1]

Major-General William F. McKee,
Assistant Vice-Chief of Staff

Lieut.-General Edwin W. Rawlings,
Deputy Chief of Staff Comptroller

Lieut.-General Idwal H. Edwards,
Deputy Chief of Staff Personnel

Lieut.-General Lauris Norstad,
Deputy Chief of Staff Operations [2]

Major-General Kenneth B. Wolfe,
Deputy Chief of Staff Materiel

Lieut.-General Curtis E. LeMay,
Commanding General, Strategic Air Command

Lieut.-General Ennis C. Whitehead,
Commanding General, Continental Air Command

General George C. Kenney,
Commanding General, Air University

Major-General Robert W. Harper,
Commanding General, Air Training Command

Lieut.-General Benjamin W. Chidlaw,
Commanding General, Air Materiel Command

Major-General Lawrence S. Kuter,
Commanding General, Military Air Transport Service

Lieut.-General John K. Cannon,
Commanding General, U.S.A.F. in Europe

Brig.-General Rosenham Beam,
Commanding General, Caribbean Air Command

Major-General Leon V. Johnson,
Commanding General, Third Air Division (G.B.)

Lieut.-General George E. Stratemeyer,
Commanding General, Far East Air Forces

Brig.-General Frank A. Armstrong, Jr.,
Commanding General, Alaskan Air Command

4. The **SCIENTIFIC ADVISORY BOARD** keeps the Chief of Staff advised of the latest scientific developments of interest to the Air Force. It reviews long-range research-development plans and reports on the adequacy of the Air Force programme.

5. The **SPECIAL ASSISTANT FOR RESERVE FORCES** is the principal adviser to the Chief of Staff on the Air Force Reserve, the Air National Guard, the Reserve Officer Training Corps, the Civil Air Guard and the Air Scouts.

6. The **AIR ADJUTANT GENERAL** is responsible for the publication of orders and instructions from Headquarters ; for the postal service within the Air Force ; the production of Air Force publications ; and the maintenance of Air Force personnel records.

7. The **SECRETARY OF THE AIR STAFF** performs executive functions for the Vice-Chief of Air Staff, plans the organization of U.S.A.F. Headquarters, provides special mission aircraft, attends Staff meetings and is responsible for a number of administrative tasks.

8. The **DEPUTY CHIEF OF STAFF—COMPTROLLER** is in charge of the Air Force's fiscal policy and administration. It is he who works out the A.F. budget requirements and supports them. He controls three Assistants and four Directorates, as follows :

9. The **Assistant for Plans** to the Comptroller develops procedures and systems to promote the effectiveness of the Comptroller organization and makes a continuing study of Air Force management to aid the Comptroller in the establishment of his policies.

10. The **Assistant for Field Management** to the Comptroller plans and directs the world-wide operations of the Comptroller system.

11. The **Auditor-General** performs all auditing functions of the Air Force, i.e., he keeps a careful check on how Air Force money is spent.

12. The **Director of Statistical Services** gathers world-wide Air Force statistics regarding personnel, operations, equipment, and interprets them.

13. The **Director of Budget** develops and coordinates budget estimates for the Air Force on behalf of the DCS-Comptroller and allocates funds for approved programmes.

14. The **Director of Programme Standards and Cost Control** develops improved fiscal and cost calculating procedures for use by the staff and major air commands.

15. The **Director of Finance** administers all phases of the receipts and disbursement of public funds for the U.S.A.F. and Reserves and reports to the DCS-Comptroller. He advises the Reserve forces on financial matters.

16. The **DEPUTY CHIEF OF STAFF—PERSONNEL** plans, directs and supervises all military and civilian personnel activities of the U.S.A.F., such as the assignment, promotion, demotion, and retirement of personnel. Responsible to him are one Assistant Deputy Chief, one Assistant and five Directorates, in addition to the Judge Advocate-General and the Chief of A.F. Chaplains.

17. The **Assistant for Ground Safety** to the DCS-Personnel advises the Chief of Staff on methods to ensure the safety on the ground of U.S.A.F. personnel. He collaborates closely with officers in charge of Flying Safety, the Surgeon General, etc.

18. The **Director of Women in the Air Force** (W.A.F.) advises the Chief of Staff and commands on plans and policies concerning W.A.F. personnel and the latter's utilization, training, administration and well-being.

19. The **Director of Personnel Planning** is responsible for studies and plans related to U.S.A.F. personnel, including such things as promotion plans, eligibility criteria, etc.

20. The **Director of Military Personnel** plans military personnel policies, reviews the current and projected personnel strength of the A.F., works out plans for the assignment of officers and men, decides on promotions, etc.

21. The **Director of Civilian Personnel** is responsible for the administration of civilians employed by the Air Force, including plans for their training, wages, assignment, etc.

22. The **Director of Training** is responsible, under the direction of the DCS-Personnel, for plans for the recruiting, career development, classification and individual training of U.S.A.F. personnel ; he works out plans for flying and technical training, the creation of training aids, as well as plans for atomic and guided-missile training.

23. The **Judge Advocate-General** acts as Legal Adviser to the Chief of Staff and supervises the administration of military justice within the U.S.A.F.

24. The **Chief of Air Force Chaplains** acts as adviser to the Chief of Staff on the religious life and related matters affecting U.S.A.F. personnel.

25. The **DEPUTY CHIEF OF STAFF—OPERATIONS** coordinates and directs the activities of the Directors of Intelligence, Plans & Operations, Communications, and Manpower & Organization ; of the Assistant for Atomic Energy, the Assistant of Programming and the Assistant for Operating Analysis. He is responsible for the coordination of overall Air Force operating programmes and joint operations with the other Services. — The present DCS-Operations, Lieutenant-General Lauris Norstad, youngest Lieutenant-General of the Air Force, will shortly be transferred to head the important unified Alaska Command (including Army, Navy and Air Force units).

26. The **Assistant for Atomic Energy** to the DCS-Operations is the Chief of Staff's principal adviser on military applications of atomic energy and directs six branches connected with this highly classified field of activity.

27. The **Assistant for Programming** supervises and coordinates U.S.A.F. operating programmes, including flying programmes, and establishes allocation priorities for equipment needed by U.S.A.F. operational units.

28. The **Assistant for Operations Analysis** undertakes scientific studies of U.S.A.F. equipment, weapons, tactics and strategy to improve such equipment and establish operational requirements. He maintains close liaison with scientific research organizations.

[1] The Editors regret to state that Gen. Fairchild died of a stroke early in March. His successor is not yet known.

[2] Gen. Norstad's transfer to the Alaskan overall Army-Navy-A.F. Command has now taken place.

The Pentagon Building, just outside Washington, houses the U.S. Defence Department, as well as the headquarters of the U.S. Air Force, Navy and Army. It is air-conditioned throughout, which means that you can't open the windows in winter because unconditioned cold air gets in, nor in summer because hot air would dilute the atmosphere. Its main passages from one floor to another consist of wide ramps—so you don't have to walk up stairs (they had the same idea in Geneva when they built the town-hall in the 15th Century !). The vastness of the place and the wilderness of its corridors, bays and offices is illustrated by a classical Pentagon joke, which claims that during the war a Western Union telegraph messenger entered the building to deliver a cable, got lost and at the end of six months emerged with the rank of a major-general.

29. The **Director of Intelligence** is in charge of all U.S.A.F. intelligence activities. He controls three Divisions, each with several branches : Policy Division, Requirements Division (which exercises supervision over U.S.A.F. Air Attachés), and Air Intelligence Division. The latter seems to be the most important, since it evaluates the offensive and defensive capabilities of foreign air powers, produces information on air installations outside the U.S.A., determines the degree of vulnerability of the war potential of foreign countries, and prepares estimates of the air strength and strategic vulnerability of foreign powers or coalitions of such powers.

30. The **Director of Plans and Operations** is responsible for politico-military, strategic and operational war planning for the Air Force and its major commands ; and for Air Force participation in joint and combined planning. Under his control are the Operations Division, which works out detailed operational plans and includes the Air Weather Branch ; the War Plans Division ; the Policy Division ; the Psychological Warfare Division and the Mobilization Division, each with several branches. This is one of the main centres of the Air Force's war planning, and most of its activities are surrounded by considerable secrecy.

31. The **Director of Communications** is responsible for all matters pertaining to communications in the U.S.A.F. He represents the A.F. on the Joint and Combined Communications Boards and the Telecommunications Committee.

32. The **Director of Manpower and Organization** has charge of plans ensuring the most efficient allocation and utilization of operational personnel and the establishment of an efficient combat organization.

33. The **DEPUTY CHIEF OF STAFF—MATERIEL** is the representative of the Chief of Staff for the planning, direction and coordination of materiel procurement, supply, industrial planning, transportation, maintenance and other services. Until very recently, the DCS-Materiel was responsible also for research and development, but a separate DCS's office has now been established to take care of the Air Force's expanding research activities. Under the DCS-Materiel's control are four Directorates, each with an incredible number of Divisions and branches. The DCS is aided by an Assistant DCS.

34. The **Joint Long Range Proving Ground Group** represents the U.S.A.F. of the Army-Navy-Air Force organizations planning long-range guided-missile research and testing. **(Note : It seems likely that supervision of this group has been transferred to the new DCS-Research and Development, but no official announcement has been released to this effect.)**

35. The **Air Engineering Development Centre** establishes aeronautical engineering programmes and projects. **(Note : It seems likely that the Centre is now also under control of the new DCS-R&D.)**

36. The **Assistant for Logistics Plans** supervises the A.F.'s logistical and strategic planning; he prepares materiel budgets and allocates materiel funds.

37. The **Director of Procurement and Industrial Planning** has charge of plans for the procurement of supplies and services, the establishment of productions chedules and of industrial mobilization plans. Under him are two Deputy Directors, an Executive, a Procurement Division, Production Division and Industrial Planning Division, each with several branches.

38. The **Director of Installations** takes care of all matters pertaining to the acquisition, construction, repair and disposal of U.S.A.F. real-estate facilities, such as air bases, U.S.A.F.-owned plants, etc. He controls, among other offices, an Engineering Division with a Construction Branch, a Maintenance and Repair Branch, etc. ; an Operations Division, with an Organization Branch and a Supply & Equipment Branch.

39. The **Director of Maintenance, Supply and Services** establishes plans for and supervises maintenance, storage and distribution of supplies and equipment procured for the U.S.A.F. He also is responsible for the provision of logistics services for the U.S.A.F. He controls separate Divisions for Maintenance, Supply, Services, and Transportation, as well as a Division carrying out these duties in the international field (U.S.A.F. overseas). Each Division has a maze of branches (which include a "Laundries & Dry Cleaning Branch" !).

40. The **Director of Armament** is responsible for the combat effectivenes of the U.S.A.F's armament. He determines the need for the development of air atomic energy weapons, allied radiological defence, disaster control materiel and techniques for employment. The Directorate comprises three Divisions : Programmes, Operation Plans and Development Planning, each with a number of branches.

41. The office of the **DEPUTY CHIEF OF STAFF—RESEARCH & DEVELOPMENT** was created only a few weeks ago. The functions of the DCS-R& D formerly were part of the responsibility of the DCS-Materiel. As the title of the new appointment indicates, the DCS-R&D is responsible for all engineering, research and development projects of the U. S. A. F. The creation of this special Staff Department emphasizes the increasing importance attributed to the research activities undertaken by the Air Force. The office, which is still in the process of organization, at present controls two important Directorates : Requirements, which was taken over from the DCS-Operations, and Research & Development, taken over from the DCS-Materiel.

42. The **Director of Requirements** establishes tactics, techniques and doctrines of aerial warfare ; operational tactical requirements for new aircraft, materiel and equipment, etc. He controls special branches for bombers, fighters, reconnaissance & photography, transport, armament and equipment, as well as a section providing liaison with Army and Navy.

43. The **Director of Research and Development** is in charge of one of the most important offices of the entire U.S.A.F. Staff. The Directorate is made up of four Divisions : Plans, Programmes and Policy ; Engineering ; Research ; and Human Resources. The first is divided into two branches, the second into eight, the third into four, the fourth into six.

THE OPERATIONAL PART OF THE U.S.A.F.

The formations carrying into effect the plans and decisions of the U.S.A.F. Headquarters Staff are the Air Force Commands. A brief list of the major ones follows.

44. The **STRATEGIC AIR COMMAND** is the overall Air Force unit grouping the heavy bomber formations of the A.F. It comprises three separate Air Forces, the Second, the Eighth, which became famous in Europe and the Far East during the war, and the Fifteenth.

45. The **CONTINENTAL AIR COMMAND** is in charge of the tactical Air Force units assigned chiefly to Army air support missions and the units which in the event of war would have to defend the U.S.A. against air attack. These forces are divided into :

46. The **Tactical Air Command,** responsible largely for ground support of the U.S. Army and other tactical missions.

47. The **Air Defence Command,** charged with the defence of the U.S.A.

Operations of the Air Defence and the Tactical Air Commands frequently overlap. Thus, fighters of Air Defence Command may also be used for ground strafing ; ground attack fighter bombers may be called upon to carry out interception or patrol work. The two commands draw their strength from six Air Forces : 1st, 4th, 9th, 10th, 12th and 14th. The 9th Air Force is the unit which furnishes troop carrier aircraft for the Army's paratroops.

48. The **AIR UNIVERSITY** is the senior staff school of the U.S.A.F.

49. The **AIR TRAINING COMMAND** provides flying and technical training to U.S.A.F. personnel. It is one of the largest U.S.A.F. Commands.

50. The **AIR MATERIEL COMMAND** is the executive unit for the DCS-Materiel, charged with U.S.A.F. procurement and maintenance activities.

51. The **RESEARCH & DEVELOPMENT COMMAND,** established a few weeks ago at the same time as the office of the DCS-R&D, carries out the latter's plans for U.S.A.F. research in all fields of military aeronautics.

52. The **AIR PROVING GROUND COMMAND** is engaged in testing U.S.A.F. equipment under all tactical and climatic conditions.

53. The **MILITARY AIR TRANSPORT SERVICE,** though under U.S.A.F. command, is a combined U.S.A.F.-Navy unit and operates extensive military air transport services to all parts of the globe.

54. The **U.S.A.F. SECURITY SERVICE** is a hush-hush organization gathering information of value to the Air Force.

55. The **HEADQUARTERS COMMAND** is a small administrative unit in charge of personnel records, etc., of U.S.A.F. members working at Air Force Headquarters in the Washington, D.C., area.

56. The **U.S. AIR FORCE IN EUROPE** controls all Air Force activities in the European theatre, notably the U.S.A.F. occupation units in Germany and Austria. It was responsible, among other things, for the operation of the Berlin Air Lift. Major U.S.A.F.E. components are fighter units.

57. The **CARIBBEAN AIR COMMAND** groups the U.S.A.F. units stationed in the Caribbean area and the important Panama Canal Zone.

58. The **THIRD AIR DIVISION,** based in England, is the heavy, long-range bomber complement to U.S.A.F.E. It consists of three groups of Boeing B-29 and B-50 "Superfortresses."

59. The **FAR EAST AIR FORCES** comprises U.S.A.F. units in the Northwestern and Central Pacific, notably the occupation units in Japan.

60. The **ALASKAN AIR COMMAND** is made up of Air Force units in the Alaskan and Aleutian area. It has much increased in importance since the end of the war owing to the proximity of the Soviet Union and the adoption by the U.S.A.F. of the long-range "Polar" strategic bombing concept.

(Continued from page 20)

of INTERAVIA REVIEW)—explains why the Air Force at the present time is expending considerable effort on the reinforcement of outlying Arctic bases, the "winterization" of all types of combat and transport aircraft and also of personal equipment of the airmen.

In order to keep its advanced outposts operational, the Air Force is devoting much attention to another prime factor, namely, aerial logistics. World War II was the first war in history in which air transportation became an essential element in logistics. The carriage by air of fuel and other basic materials by air still is an extremely expensive process as compared with sea and land transport, but its use over the Himalayan "Hump" from India to China during the last years of the war and its more recent spectacular use in connection with the Berlin Air Lift gives an idea of what the future may bring. Chiefs of the Military Air Transport Service, which, includes air transport units of the Air Force and the Navy, have reported to Secretary of Defence Louis A. Johnson that a year of supporting the Berlin Air Lift gave the Service the know-how to carry out, if required, intensive strategic air lift operations anywhere in the world.

The U.S.A.F. looks after the comfort of its members. The entrance to the Officers' Club at Hamilton Air Force Base, California.

Interior of the Officers' Lounge at March AFB, California.

The Boeing B-47 "Stratojet" medium bomber takes off like a giant arrow, aided by 18 JATO (= jet-assist take-off) rockets. The B-47 is on order for the U.S.A.F.

The U.S. Air Force has been accused of becoming so sold on a theory of winning wars by strategic bombardment alone that it has allowed tactical air power for the support of ground forces to die from neglect. This is inaccurate, however. New tactical aircraft types are constantly being developed (the Martin B-51 three-jet bomber is a notable example), and squadrons of Republic F-84 "Thunderjet" fighter-bombers are ready to act in support of the Army. In addition, the U.S.A.F. has recently created a Tactical Air Command with headquarters at Pope Field, Fort Bragg, N.C., as the opposite number to the Strategic Air Command.

It certainly is true that there exists a group of Air Force generals who are of the opinion that in the event of war with Soviet Russia it would be possible to knock out the enemy by means of a sudden blow against a group of carefully selected military and industrial targets. One of these is Lieutenant-General George C. Stratemeyer, now commanding the U.S. Far Eastern Air Force, who believes that upon the outbreak of hostilities "a crushing, paralyzing final retaliatory blow should be delivered immediately." This is not the official doctrine either of the Air Force or of the Department of National Defence, however. The Air Force is following a policy providing for a "balanced force" of offensive and defensive (interception) strategic units as well as tactical units. It proposes to play a well-defined part in a balanced national armed force consisting of an integrated Army, Navy and Air Force.

The late James Vincent Forrestal, America's first Secretary of Defence, was of the opinion that within the next five years American air power would assume the role of keeping the peace throughout the world, a role played by British sea power during the last century. Chiefs of the United States Air Force are certain that, if given the support by Congress and the American people they have requested, they will be able to play this role.

USAF

Air Force trains "Super-Navigators" for "Super-Bombers"

Training on the ground : Cadets work out navigation problems. The instructor stops to help one student out of his difficulties. The others listen to profit from his explanation.

The keyman to the bomber team is the navigator, for it is he who navigates the bomber to its target and back to safety, mostly under adverse conditions such as enemy opposition or bad weather, or both. His importance in a future war would be even greater than it was in World War II : the new bombers are much bigger and costlier than in the last war ; crews are more highly trained and represent a greater investment ; distances will be longer, perhaps "intercontinental"; and enemy defences will certainly have improved over what they used to be.

The U.S. Air Force proposes to be ready in case it is ever called upon to put its global air strategy into grim effect. Its future navigators are being put through a new, up-to-date training programme at Ellington Air Force Base, in Texas.

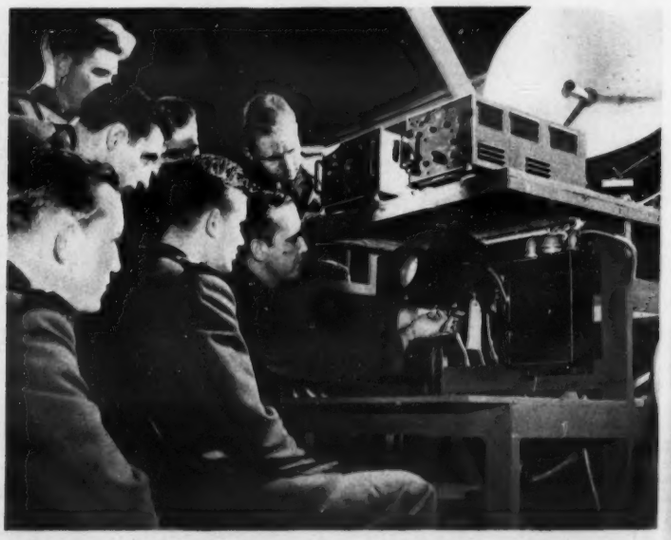
The Air Force navigator must know how to guide new high-speed long-range bombers and cargo transports over endless wastes of water and waterless wastes without checkpoints. He must pay constant attention to gasoline consumption, a major problem on long-range flights. He must be able to handle a variety of computing instruments, from circular slide rules and sextants to radio and radar equipment.

The first class of navigators started its new training schedule last November. The programme covers all phases of air navigation and requires forty-eight weeks. It includes 184 hours of in-flight navigation in the U.S.A.F.'s new Consolidated-Vultee T-29 crew trainer, the service version of the "Convair-Liner." Flying is supplemented by intensive ground training in "synthetic" trainers.

Upon graduation the navigation cadet is commissioned a Second-Lieutenant in the U.S.A.F. Reserve with an aeronautical rating of Navigator. All graduates will be assigned to a three-year tour of flight duty with the long-range bombers of the Strategic Air Command or the cargo transports of the Military Air Transport Service.

Cadets receive their first introduction to the so-called "supersonic trainer," a device simulating high-speed flight over a given area. This is one of many modern training aids employed at Ellington A.F.C. Long-range bomber and transport navigators won't fly supersonic aircraft in the foreseeable future.

Captain Emory C. Morgan, instructor, demonstrates advanced radar navigation methods at the radar scope.



Navigator cadets belonging to the first class at Ellington A.F.B. are taught the use of the dead-reckoning computer as the instructor explains its use on the enlarged wall replica.

The effect of wind on the course of the airplane in flight is demonstrated by another training aid.

Enlarged reproduction of current cockpit instruments are used to study details of technical phases of air navigation. Instruments are mere mock-ups.

Instructor Lieutenant Allen Miles, of Nashville, Tenn., uses the sextant, a device for determining navigational position with reference to stellar bodies. "Shooting the sun" or "shooting the stars" is the term dubbing the process.

Approaching the operations room after a session of flight training are Cadets Marion Becker, of Stuttgart, Arkansas; Herbert Massie, of Stuarts Draft, Virginia; and J. A. Jeter, of Omaha, Nebraska.

All is not work. Here, in the Shamrock Hotel lounge at Ellington, Cadets Bud Massie and Marion Becker meet their dates for an evening out, Doris Harris, left, and Lillian Thokar. Operating with charts and sextants all day seems to sharpen cadet's instincts for finding interesting points and curves in the Texan wastes.

USAF

Air Force Engages in Ten Fields of Research

No less than ten general "areas" of research make up the U.S. Air Force's current Research and Development Programme, Major-General Donald L. Putt, Director of Research and Development, told the annual meeting of the Institute of the Aeronautical Sciences in New York on January 25th. They are the following : (1) Background research ; (2) basic research ; (3) flight at faster speed ; (4) recognition and hitting of targets ; (5) ability to cause destruction ; (6) all-weather operations ; (7) defeating enemy interference ; (8) communications ; (9) defence of home territories ; and (10) utilization of personnel.

Background Research (Area 1) covers a programme of study and research to investigate preferred methods and techniques in the conduct of *intercontinental air warfare* in the interest of most effective national defence.

Basic Research (Area 2) comprises fundamental studies for the discovery of new knowledge which may be of value to the Air Force. The most difficult problem here is that of selecting the most promising subjects of research and concentrating on those in which there is the greatest likelihood of success. The task of solving this problem has been assigned to Air Material Command's Office of Air Research, which works out basic research programmes. At the end of the 1949 fiscal year, the Air Force had in effect more than 400 research contracts (in addition to its own work) with a total face value of $75,000,000.

Flight at Faster Speed (Area 3) forms one of the most complex fields of Air Force research. Work is concerned with the testing of new, fast aircraft (such as new jet bombers, experimental supersonic aircraft, jet fighter prototypes), as well as the endeavour to reconcile the alternative abilities of aircraft to fly at high speeds or over long ranges with heavy loads.

This area also covers the development of guided missiles for the following combat uses : air-to-air, air-to-surface, surface-to-air, and surface-to-surface in both the short-range tactical and long-range strategic categories. The Air Force guided-missile programme has been integrated with those of the other Services to form an overall national research programme.

Power plant research is conducted by the U.S.A.F. under the same heading, and the main emphasis is being placed on the development of pure-jet engines and rockets for jet-assisted take-off. Less importance is at present being attached to the development of propeller turbines and reciprocating engines. Steady progress is being made also in the art of ram-jet development. Finally, the Air Force-sponsored Nuclear Energy Propulsion for Aircraft project (NEPA project, managed by Fairchild) is continuing.

Recognition and Hitting of Targets (Area 4) involves the improvement of long-range navigation methods and instruments. The Air Force has initiated projects to make navigation completedly automatic. A light-weight airborne navigational search radar equipment for use in transport equipment has been developed.

Progress is being made in developing an accurate bomb aiming device, and a new bomb aiming and navigational system is undergoing engineering tests. Considerable effort is devoted to increasing the stability of bombs in flight. It has definitely been determined that bombs used during World War II are not satisfactory for release at high altitudes or at high speeds, as the stabilization provided for them is not sufficient. New bomb fin assemblies for some World War II bombs have been designed and ordered as an interim solution.

New methods of operating fire control and airborne gun-laying equipment are being evolved, since operational deficiencies in World War II equipment were found at modern high speeds.

Ability to Cause Destruction (Area 5) : The Air Force has determined that the diversity of bomb sizes in existence during World War II and in storage at this time exceed requirements. A new "family" of bombs of optimum sizes is now being elaborated.

Research is also going on to develop a new family of warheads and fuses for guided-missile application, where extremely rigid weight-performance requirements prevail.

All-weather Operations (Area 6) : The Air Force is engaged in intensive research and development to ensure that it can function independently of weather and darkness. A major part of this work is the study of the atmosphere above 200,000 ft. The Upper Air Laboratory at Cambridge, Mass., is conducting research in this meteorological frontier, designing specialized instruments, fitting them into rocket warheads, and arranging the rockets to be fired at Holloman Air Force Base and White Sands, New Mexico.

The Atmospheric Physics Laboratory at Cambridge is concerned with supplying the answers to problems involving the chemical and physical properties of the atmosphere, which are of outstanding importance in the guidance of missiles and the operation of high-altitude aircraft. For example, at speeds several times that of sound a small variation in air density is a large factor in missile control system design.

The Air Force's all-weather projects are of buring interest to commercial aviation. This programme has therefore been coordinated with the Department of Commerce through the Air Navigation Development Board.

Ability to Defeat Enemy Interference (Area 7) : To evade enemy action, the U.S.A.F. is sponsoring the development of bomber aircraft which will fly roughly at double the speeds and altitudes of World War II aircraft ; thus, the attacking fighter no longer enjoys marked performance superiority over the bomb carrier. Three new penetration (escort) fighters, the MacDonnell XF-88, Lockheed F-90 and North American F-93, are being evaluated to meet production requirements for this type of fighter.

It has been determined that, for tail protection of future bombardment type aircraft, the Air Force will require weapons other than those currently available. A staff study has been made on current armament deficiencies in service aircraft, with the result that a considerable number of corrective projects were initiated by the Air Force from Fiscal Year 1949 funds.

Communications (Area 8) : The use of aircraft for military purposes requires radio communication equipment which falls into two distinct classes : long-range ground-to-air up to 6,000 miles ; short-range ground-to-air and air-to-air up to 250 miles. Present Air Force research places emphasis on means of increasing the range of long-distance communications ; providing anti-jamming ; reducing size and weight of short-range equipment for jet aircraft ; investigating atmospheric factors impairing communications.

Defense of Home Territories (Area 9) : Interceptor studies are presently being conducted by the major aircraft and equipment industries, with a view to counteracting the flexibility of enemy attack derived from recent increases in speed, range and combat ceiling of bombardment aircraft. Required is a high-performance interceptor fighter capable of operating at night and in any weather, since range limitation of ground search radar, combined with the high speeds of attacking bombers, narrows the interception period. Consideration is being given to the design of a fighter with low wing loadings to reduce the radius of turn at high altitudes. The desirability of transonic and supersonic speeds for interceptors is also being investigated.

Extensive improvement in the ability to defend local areas will be afforded by the addition of guided missiles as armament for interceptor aircraft and by the introduction of anti-aircraft guided missiles.

Considerable effort is being devoted to the extension of ground radar ranges and the elimination of the human element in the chain of events occurring from the initial detection of the target to the final interception.

Utilization of Personnel (Area 10) : The U.S.A.F. has established a broad and comprehensive research and development programme in the field of human resources. This programme includes work in five domains : (1) "Human engineering," i.e., study of physical and mental reactions and resources of the human being ; (2) training methods and requirements ; (3) optimum utilization of available manpower ; (4) human relations and morale ; (5) planning and administration.

This, then, is a rough outline of the ten "areas" in which the U.S.A.F. is conducting research and development work. Each of these areas is broken down into a multitude of categories and individual problems, ranging from the development of high-speed airfoil sections to the establishment of new methods of strategic intelligence and the determination of human reactions under specified forms of physical stress. How the Air Force goes about the solution of some of these individual problems is shown on the following pages.

USAF

U.S.A.F. Research

Death gets a "Bronx Cheer" from the Air Force

BY SCHOLER BANGS, LOS ANGELES

More than once it has happened that fast modern aircraft—fighters, bombers, troop transports or commercial airliners—have shot off the runway in an accidental landing stall and plowed through some adjacent airport installation. Brakes may fail, and the aeroplane may roll merrily beyond the end of the runway and come to a jolting halt nose-down in a ditch. Failure of landing gear, of propeller reversing controls, of engines may translate a glide-speed landing approach into a sudden stop, with the finger of death touching the luckless occupants.

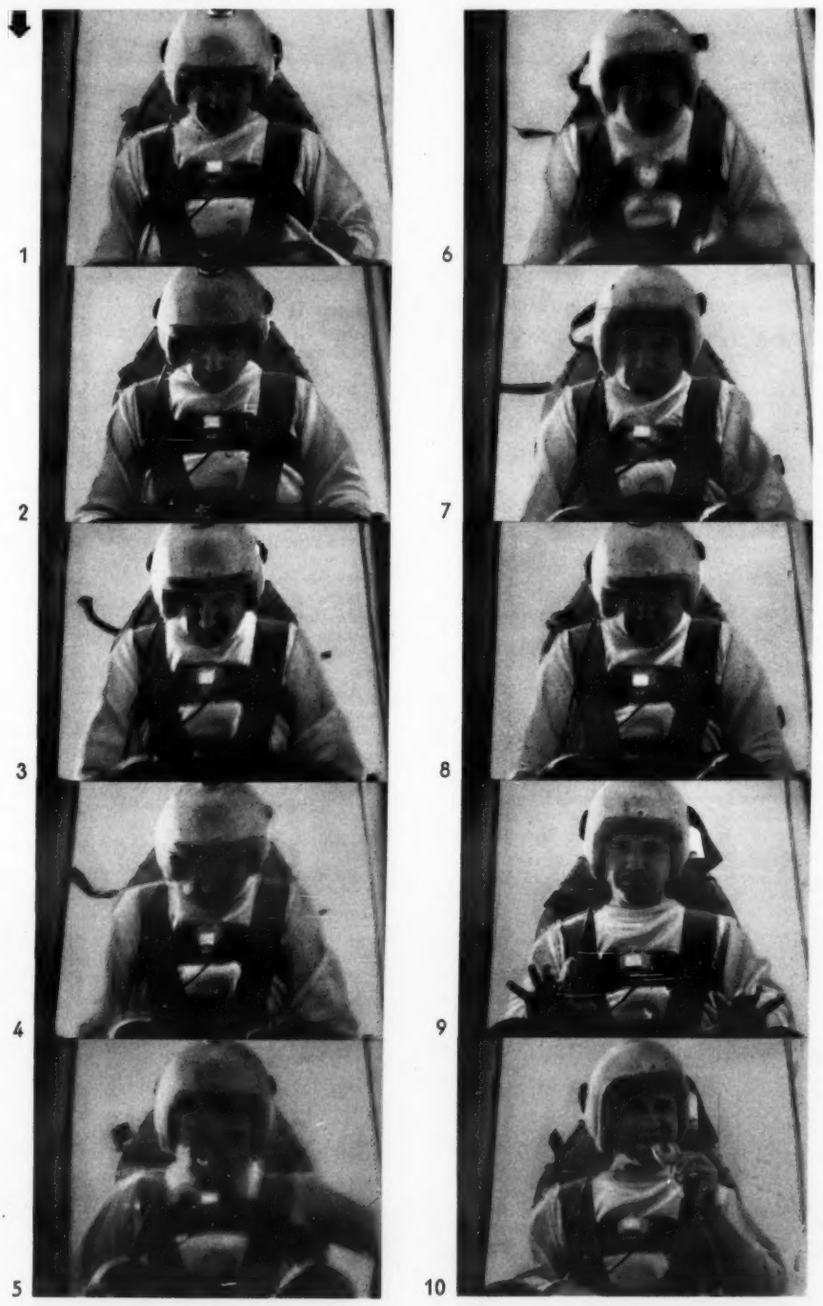
Need they die ?

Conducting a minute part of the U.S. Air Force's research activities in every field of aeronautics, Air Force aeromedical experts are on the point of delivering, dramatically and in public, the "Bronx Cheer" at the Grim Reaper as he grimaces at the participants in air crashes.

Air Force tests still under way in California have shown that death from moderate to severe landing crashes can be escaped by the simple expedient of clasping the occupants of aircraft to securely-anchored seats with strong shoulder and chest harnesses. The significance of these findings does not lie alone in the fact that Air Force pilots and crew will stand a better chance of survival should their aircraft have to make a forced landing or anything go wrong during the landing approach. Airline presidents, who are loath to ponder out loud the question, "Need they die ?," will now find themselves *forced* to do so, quite simply because the U.S.A.F.'s experiments have clearly shown that the time has ended when operators could side-step, as "fear-producing," the things they can do to cheat the coroner when the crash comes. In the undramatic phrasing of test reports they have been told that passengers soundly secured can survive sudden stops—as in a crash—delivering up to 35-G stresses to the body.

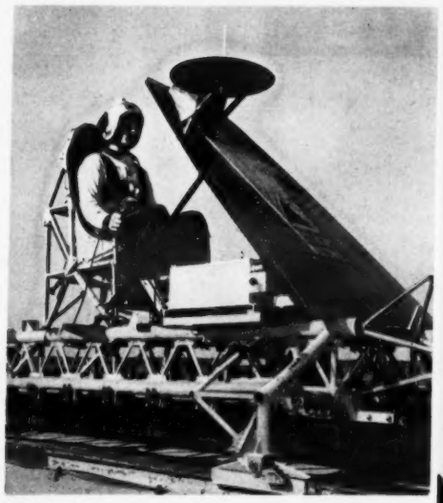
What has long been suspected, and conceded in the harnessing of military pilots to the seats of their aircraft, now has positively been

Selected frames from a high-speed motion picture film show these effects on a volunteer decelerated from 150 m.p.h. to a halt aboard Northrop Aircraft's rocket sled. Body and face distortions took place in only a fraction of a second of complete deceleration, comparable to the impact of an actual airplane crash. No ill effects were experienced, although the impact load was 35 G. In last picture the smiling volunteer removes boxer's mouth guard, employed to prevent possible biting of tongue during test.



Historic moment in the Aeromedical Laboratory's decelerator project was this success ful completion of the first manned run. Major John Stapp, aero-medical officer in charge of the tests, volunteered for the first bone-jarring ride into "the world's most powerful braking system." He evidently suffered no ill effects.

An important phase of the preparations for each test run is the strapping-in of the volunteer, in this case Corporal Raymond Leach. Volunteer is "installed" according to rigid specification for adjustment and attachment of straps.



Muscles tense, senses alert, Corporal Leach awaits fixing of the rockets for another ride. Decelerator carriage chassis has been stressed for 100-G's with

proved in the slam-bang crash testing of human guinea pigs in the aeromedical research program developed jointly by Air Force and Northrop Aircraft Co. The "victims" are harnessed to a conventional seat securely mounted on Northrop's rocket-powered rail sled at Edwards Air Force Base (formerly Muroc Air Base) on the Mojave Desert. Hurled forward at a speed of 150 mph., the sled is braked to 75 mph. in 1/5 second. Briefly sore neck muscles have given the only complaint from "passengers" who probably would be dead had they been secured only by conventional lap belts during their simulated "crashes." Just how great a crash impact the trussed-up human body can sustain without injury remains to be seen. The tests are continuing.

The rocket sled, originally designed to serve as an outdoor wind tunnel, carrying airfoil shapes at supersonic speed the length of a 2000 ft. track, is rigged to enter the braking zone at speeds up to 240 mph. and to produce accurately recorded decelerations of as much as 50-G.

Major John P. Stapp, Ph. D., Air Force flight surgeon in charge of the tests, who personally rode the rocket sled on its first human deceleration test, is amazed at the results shown to date. He said :

"The human body, sometimes believed to be as fragile as an egg, has almost unbelievable ability to withstand shocks under certain cir-

How it Works

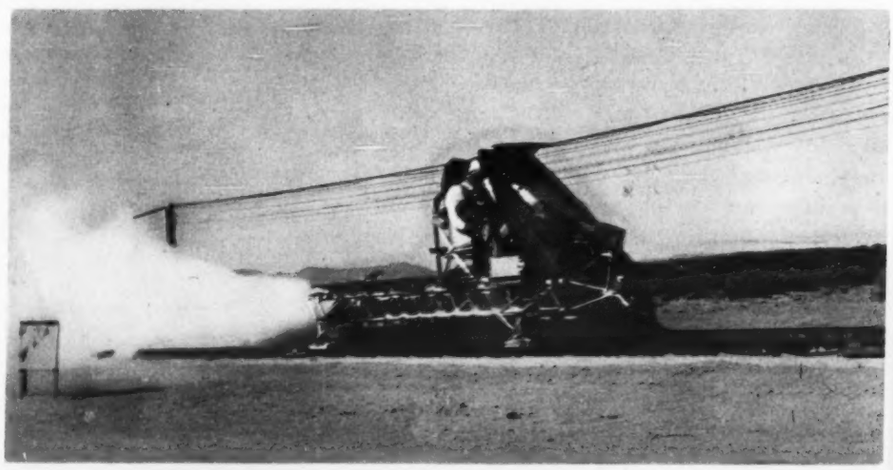
The air crew decelerator, developed by Northrop Aircraft, Inc., in reality is a rocket-propelled "railway carriage" mounted on slides, or "slippers," in lieu of wheels. The carriage, which weighs 1500 lb., is of welded tubing construction and stressed for 100 G's with a 50-percent safety factor. Cab atop chassis is of lightweight construction, intended merely to shield occupants and instruments. The carriage measures 178 in. by 80 in. by 74 in. Track length is 2000 ft., including 50 ft. of braking area.

Power is supplied by four rockets of 5000-pound-seconds thrust each. Braking begins at a point 1,250 ft. from the starting end of the track. It is accomplished by 45 mechanism units, each consisting of two pairs of clasp type brakes installed in the road bed. The brakes clasp two armour-plate braking blades or rails, each measuring 134 in. by 5 in. by ½ in., attached beneath the chassis of the decelerator carriage. The 180 brake shoes, each measuring 55 sq.in. in area, are constructed of special soft cast iron molded on steel webbing. Each shoe—activated hydraulically—is capable of exercing a pressure of 33,000 lbs. An emergency braking system is installed near the extreme end of the track. This consists of a flexible steel cable stretched across the track at right angles. The cable is wound on hydraulically-loaded reels on each side of the track. A hook on the front of the decelerator carriage engages the cable whenever the car enters the emergency area. Tension applied to the cable through the hydraulic reels brings the carriage to a halt.

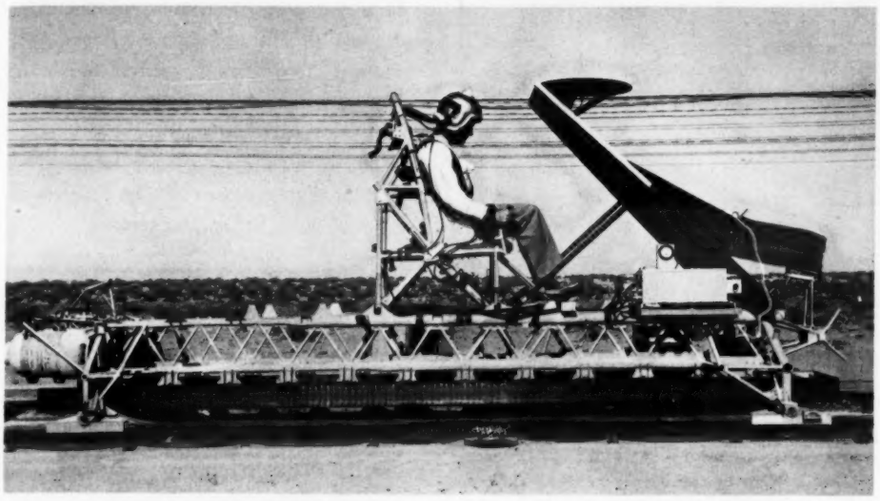
In order to obtain information during the brief period of the actual test, Northrop electronics experts devised a miniature radio transmitter capable of sending four simultaneous signals and mounted in a special cushioning element which enables it to function even while subjected to the enourmous shock as the carriage enters the brakes.

Four accelerometers are mounted within the carriage, attached either to the occupant or to the chassis. Data from these accelerometers are transmitted through the telemetering equipment to a control tower. Signals generated by stress gauges attached to various parts of the volunteer's body can be similarly recorded.

Timing of test run is recorded by a space-time recording system consisting of coils mounted at 25-foot intervals along the track, except in the braking area, where coils are mounted every foot. A magnet attached to the carriage actuates each coil as it passes over it, flashing a series of lights in the control tower. These flashes are photographed by a high-speed camera and provide a permanent record. Provision is made for mounting motion picture cameras inside the carriage in forward, aft and profile positions. The frames of a "decelerated volunteer" on this (preceeding, next) page were recorded by such a camera.



Spewing white plume of smoke, rocket-propelled decelerator roars down its track, headed for the braking area.



a 50-percent safety factor. Disk at upper windshield edge supports tiny telemetering antenna broadcasting signals denoting volunteer's reactions. Knife-like brake-blades are suspended beneath 1500-lb. carriage.

cumstances. It isn't too much to hope that by testing safety devices in the decelerator we may be able to make air crashes much less serious."

Admittedly, the artificial crashes of the decelerator are not indicative of impact stresses which are common to all aircraft accidents. But there is ample evidence that the 35-G shock loads survived by the decelerators volunteers exceed those which have been fatal to many a victim of an airliner crash.

The effect of a 35-G sudden stop was evidenced in preliminary decelerator tests with a man-size dummy, "Captain G" (for gravity).

Insecurely strapped, Captain G was torn from the seat when the carriage hit the braking area. His body tore through the metal wind screen of the sled at such velocity that observers were not aware what had happened. A cloud of desert sand erupted 700 feet ahead of the sled, and only subsequent investigation disclosed that it had been caused by the impact of Captain G's "body."

In the human tests there have been no casualties, and no lasting ill effects from taking the 35-G loads either in forward-facing position or with the chair reversed.

There has been evidence that in the forward-facing decelerations there is no likelihood of head or neck injury as long as the upper body is firmly secured. With the chair reversed, however, it is vital that the head be secure against its headrest before impact.

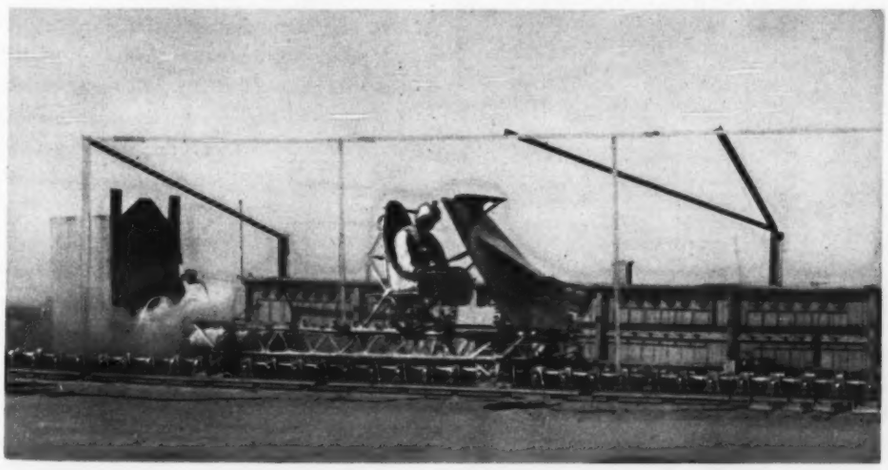
How effective the securing of the upper body can be, in a crash, was demonstrated not long ago in the Los Angeles area when an F-80 pilot cartwheeled his jet fighter in a landing crash. His skull, protected by a modern crash helmet, showed no outward evidence of injury. However, he died, and post mortem examination disclosed severe brain damage from impact with the sides of the cockpit. This pilot had failed to tighten his shoulder harness preliminary to his landing approach. Aeromedical authorities were confident that had he done so he would have walked away from the wreckage uninjured.

Actually, it should not have required anything nearly as complex as the rocket sled tests to demonstrate that lives might be saved by the simple immobilization of the human body in a strong seat structure.

Early aeromedical experiments demonstrated the serious if not fatal aspects of head and neck injuries in crashes resulting from sharp localized impact against solid structures. General adoption of the shoulder harness for fighter pilots reduced materially the injury and death of these airmen in planes which were particularly susceptible to landing accidents. As a further protection, seat structures were strengthened and, in some aircraft, were designed to withstand 40-G pilot loads without tearing loose from the anchoring airframe.

It is surprising, in the face of good results from such safety improvizations, that the application of body immobilization techniques has not extended into the passenger transport field. Neither the Air Force nor Navy air arm applied the shoulder harness idea to their personnel transports. Their closest approach to providing crash impact protection was in pre-take-off instructions to passengers boarding over-ocean land transports which might be confronted with a water ditching and its crash-sudden deceleration. Passengers were given detailed instruction upon the cushioning

The bone-jarring jolt of deceleration. Notice how deceleration has forced volunteer's head forward.



Physical examination of volunteer immediately before and after decelerator run provide much of data gleaned by Aero-Medical Laboratory. Here Major John Stapp, aero-medical officer in charge, tests reflexes of Corporal Raymond Leach, a regular decelerator volunteer.

Inspection of decelerator braking area is conducted before each run. Northrop Aircraft devised the braking system.

A pair of the special brake shoes which provide the lightening-quick stops required for the "crash" tests is examined by Ed. Denzin, Northrop project engineer, and Major John Stapp. The brake shoes are made from a special type of soft cast iron and were developed by the American Brake Shoe Company. The decelerator installation is described as the "world's most effective braking system."

Braking area contains 45 sets of brakes, consisting of two pairs of brake shoes each. Brakes are capable of exerting 2,000,000 pounds of pressure—enough to halt a 3,000-lb. automobile travelling 100 miles an hour in less than three feet. Brakes are actuated hydraulically, and any combination of the 45 sets can be set to grip the brake blades of the decelerator carriage. Picture shows a technician setting the brakes in preparation for a run.

of foreheads upon their arms, and unseated passengers were shown how to brace their backs and head against vertical bulkheads while facing toward the rear of the cabin.

That commercial airlines should have given even less outward consideration to the crash protection of their passengers has been excusable, up to now, for several reasons.

The chief of these is the "public reaction" bugbear.

Since its inception, the commercial air transport industry has been confronted with the awkward fact that airplanes *do* crash, while at the same time it has felt the necessity of selling its cash-on-the-counter public the idea that flying is safe. Obviously, any equipment in the cabin which would call attention to the possibility of disaster might undo "safety" salesmanship.

The existence of the lap belt in today's airliner must be attributed to the fact that it has been an accepted flight accessory since the days of the first airplanes. The flying public needed no indoctrination in its use and purpose. But beyond this . . .

Airline executives on several occasions have had cold shudders over efforts to promote the requirement of parachutes for passengers, and at some cost in lobbying and "preventive publicity" they have quashed successive passenger parachute legislation forays.

To suggest that passengers subject themselves to being strapped rigidly to their seats by shoulder and chest harnesses before take-off and landing probably would be just as distasteful to the airline executive mind.

Until now they have had reasonable arguments to hurl against such proposal. In the case of the fighter pilot, confronted constantly by the risks of violent crash landing, the shoulder harness very well can be a life-saving "must." In view of the low incidence of transport landing and takeoff accidents, it would prove only a needless discomfort to the commercial passenger. The frightening aspect of having to educate the public to acceptance of such equipment, and having to risk a temporary loss of business by implication that with his ticket the passenger is buying a reserved seat in a potentially dangerous crash, are equally persuasive against any sudden move toward equipping airliners with complex body harnessing systems. In view of the test results obtained by the Air Force the arlines have no such excuses for avoiding at least serious consideration of this method of reducing crash landing casualties.

The Air Force deceleration tests, supervised by Major Stapp in his capacity as research scientist of Air Material Command, show that the properly-secured human body can survive without evident harm impact loads which, without proper harnessing, would be fatal.

While final reports have not yet been issued on details of the Air Force-Northrop deceleration experiments, a preliminary review of the project should be of tremendous interest to the air transport industry as a whole.

Considerable secrecy obscured the tests until Major Stap possessed conclusive evidence that for brief periods—as in the split-second moments of an actual crash—the properly braced human can withstand regularly decelerations up to 35-G, and even impact loads as high as 57-G for fractions of a second.

Major Stapp is certain on this point, and during an interview said :

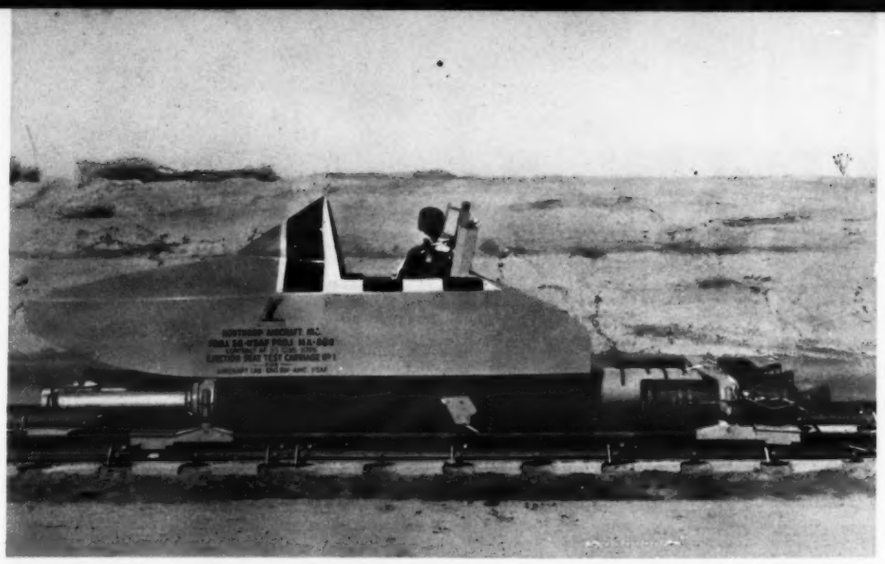
"There is no impairment of vision, hearing or consciousness, and no more aftermath than a person would feel if he had indulged in brief violent exercise. There is no reaction on internal organs. Our tests show that up to a point the body has tremendous elasticity, and for fractional periods of time can deform without injury. Time is the all important factor in survival of high G loads. To avoid injury, the pressure imposed on the body must be relieved mighty quick." While comparative data has not yet been released by Major Stapp, it would seem that rocket sled decelerations probably have followed closely those created in severe crash landings of transport aircraft.

Reviews of airplane accidents indicate that impact loads in crash deceleration come in a series of short-period jolts, between which there is momentary relief of high G loads.

In the Northrop rocket sled tests the load time factor has been a vital consideration, and a typical run shows a deceleration from 150 m.p.h. to a stop in 0.16 seconds over a braking (crash) distance of 24.6 ft.

Continuation of the tests probably will bring to a conclusive solution the recognition of just how much of a crash shock a human can stand and equipment necessary to enable him to survive the imposed loads.

At the time of Major Stapp's disclosure of the experiments eight Air Force volunteers, including himself, had made a total of 47 trips aboard the rocket sled, 14 of them to loads exceeding 30-G.



Here we are again : this 2300-lb. test sled—"sister ship" to the decelerator—races down the track at Edwards Air Force Base at speeds up to 1,100 m.p.h. and at its maximum speed catapults a dummy from an F-86 ejection seat. Unlike the decelerator carriage, it is brought to a halt by forward-firing rockets. Purpose of tests is to determine the effect on pilots when bailing out from aircraft travelling at extremely high speeds.

To prepare for the impact of a simulated crash the volunteer is secured to the seat by a series of wide nylon web straps encircling each thigh, across the lap, across the chest, and over each shoulder. Each arm is secured against movement by wrist straps, and the feet are inserted in restraining loops.

Envisioning such body confinement applied to a timid airline passenger might be discouraging at first glance. However, in airline application of the system the passenger who is unfamiliar with the harness would be assisted, before flight, by his stewardess. Quickly and easily she would adjust and secure straps "tastefully dyed" to match the decor of the cabin, and take up any adjustement slack by the simple movement of a strap tightening lever beside the seat. She would "request" that until airborne (or landed) the passenger make use of the seat arm wrist loops and foot braces. In mid-flight the bulkier segments of the harness would tuck into seat cushion pockets, leaving the conventional lap belt immediately handy for use in turbulent air. Once "sold" on the idea that the somewhat bulky harness does not reflect a constant hazard of flight, but merely is a "plus" offering by an airline ever mindful of the safety of the precious bodies of its customers, the ticket holder probably will give no more thought to the device than he formerly accorded the single-strap lap belt.

Continuing its efforts to save its most valuable commodity, namely, its combat and transport pilots, the U.S.A.F. is now using another type of Northrop rocket sled to test its ejection seat—which has proved successful in permitting jet pilots to escape from disabled aircraft at speeds up to 555 m.p.h.—at speeds exceeding that of sound. In place of the rockets fitted to the sled in the deceleration tests, a maximum of fifteen 10,000-pound thrust rockets are used to propel the 2,300-pound sled, containing a seat of the model employed in the North American F-86 "Sabre" jet fighter, along the two-mile track at speeds ranging up to 1,100 miles per hour.

Purpose of the present tests is to find out what added protection is required for a pilot's face and body when he bails out at supersonic speeds, as well as to determinate the speed limitations of the present seat. This seat was first thought to be satisfactory only at speeds up to 600 mph, but it is now believed that it will perform well at speeds at least up to 700 mph. If it is found that the present version cannot get a pilot free of his disabled aircraft at transonic or supersonic speeds, research will be conducted to improve it or devise other means of escape.

The test vehicle works like this : a fixed number of rockets attached to the sled are fixed simultaneously, propelling the carriage forward at a predeterminated speed. At about the half-way point, when the desired velocity has been reached, the F-89 ejection seat catapults a dummy clear. The sled continues whizzing down the track but is stopped before reaching its end by firing ahead of it a number of rockets having about half the original propelling thrust. These forward-firing rockets bring the vehicle to a stop within less than a mile after the dummy is ejected. Total weight of the ejected mass is about 310 pounds, including seat and dummy. Elaborate equipment, including movie cameras and telemetering instruments, has been set up to check all forces acting on the dummy.

USAF

U.S.A.F. Researchers Play with Models

Back in 1945 the U.S.A.F. Air Materiel Command began flight-testing a highly unconventional cargo glider prototype, the XFG-1. Months of wind tunnel tests of a non-flying model of the design, which featured swept-forward wings set far back along the fuselage, had stamped it as a clean, airworthy aircraft. The glider, according to all calculations, would easily recover from a spin. In its first test flight, the pilot kicked it over on one wing into a spin. The XFG-1 never came out. The pilot was killed.

As a result, Headquarters of Air Materiel Command ordered construction of a remotely-controlled free-flight scale model of the XFG-1 to obtain additional data before attempting another actual flight test. This course of action was dictated by the fact that in conventional wind tunnels models sit stationary on mounts, and tests do not set up true aerodynamic movements of flight. A few months later the scale model of the XFG-1 was launched from a Navy blimp over Lakehurst, N.J. Together with subsequent full-scale flying trials, these model tests determined that the XFG-1 was inherently a bad spinner. The design was abandoned.

The experiments with the first scale-model glider have meanwhile grown into Air Materiel Command's Dynamic Model Unit, a division of the Aircraft Laboratory devoted exclusively to designing, manufacturing and testing replicas of U.S.A.F. aircraft. Chief of the unit is Adam J. Stolzenberger, a pioneer in model aircraft research, who sparked the idea of using scale models for dangerous tests during the war years when he was a test pilot-engineer with the Command. He now is employed as a civilian.

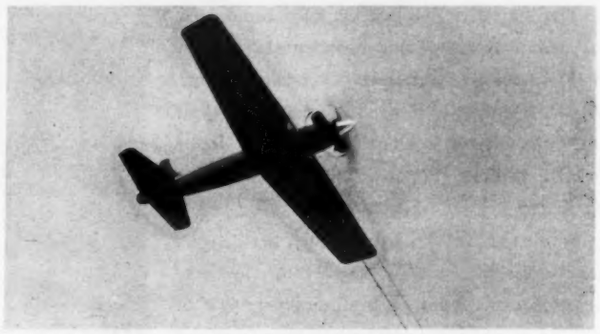
The Unit at present is turning out two types of aircraft model—radio-controlled free-flight scale designs and control-line models. The former are used to study the attitudes of a new design and its aerodynamic characteristics about three axes ; the latter can provide data pertaining to movements about a single axis.

To fly its control-line models, the Unit maintains a miniature airport in close proximity to the giant super-bomber runways at Wright-Patterson AFB. This "airport" consists of a circular runway measuring 400 feet in diameter. In its centre is located a pivot, or control-line base tower, for flying the models. Outside the circle there is a full-size cockpit mock-up where the "pilot" sits and manipulates regulation aircraft controls. Strong, thin wires connect to the model's control surfaces, enabling the operator to fly it as he would a full-scale aircraft.

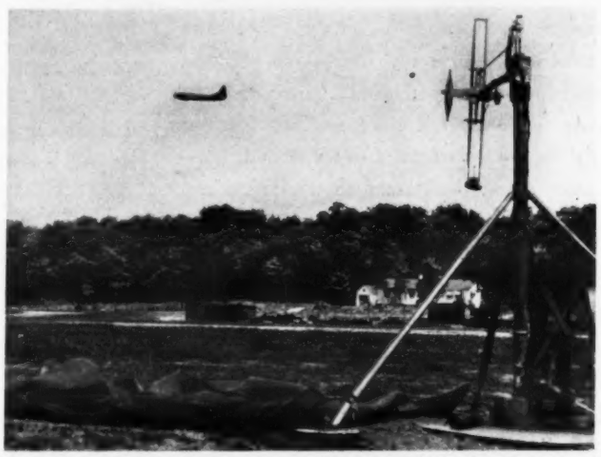
The miniature airport is slated for an innovation soon : a unique air vent which will blow a vertical column of air across the path of the flying models to simulate the effect of an aircraft entering a violent updraught. Plans are also being made for the establishment of a separate free-flight experimental base somewhere in the desert, where proposed subsonic, transonic and supersonic models can be tested.

The models the Unit turns out vary in size. They might be anywhere from a small four-foot wing span model, such as that of a recent high-speed midget, up to the 20-foot wing spread on a big bomber model just completed. It can take from six weeks to nine months to build a model from plans to product, and the cost can run as high as $25,000. Each model incorporates an elaborate system of test recording devices, cameras and safety chute built directly into the framework. Work has now been started to place the Unit on a more rational production basis. In future, hand-made master model of each design will be turned out, and from this inexpensive plastic replicas will be manufactured on an assembly line basis. These will be used in high-speed tests in which they must be classed as expendable.

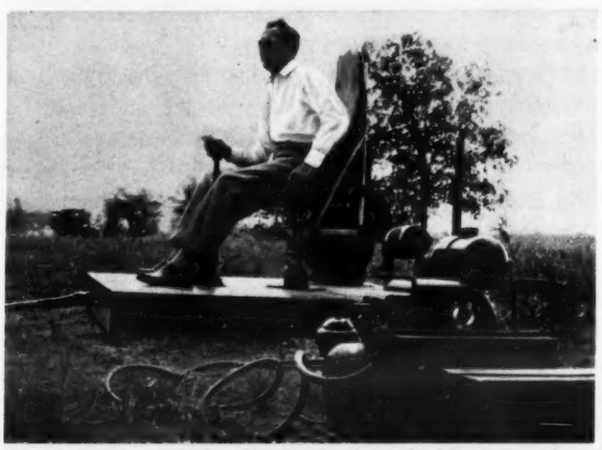
Perhaps the most impressive replica yet to come out of the unit's workshop is a free-flight model of the Northrop B-49 "Flying Wing" eight-jet bomber



This is one of the Dynamic Model Unit's all-purpose control-line models which has already paid its way many times in terms of valuable data obtained from its flights. Sturdy and adaptable, it is one of the Unit's "workhorses."

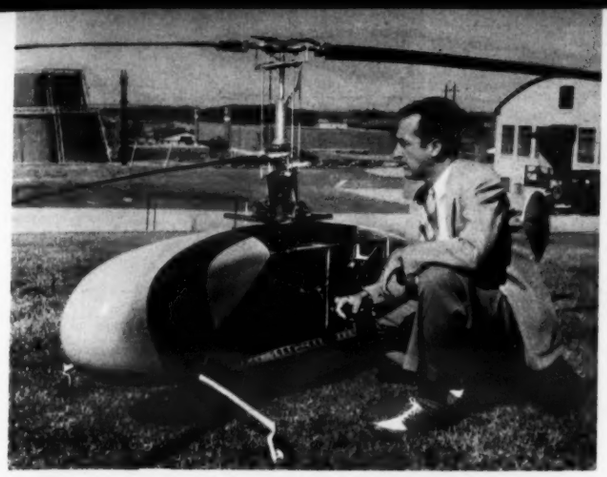


Here the control-line base tower from which the models are flown is pictured in operation.



The operator's "cockpit" outside the circular runway features regulation aircraft controls. Handling them is Adam J. Stolzenberger, chief of the Unit. The strong, thin wires connecting to the model's control surfaces are visible at left.

Model Unit technicians run up the miniature Boeing B-17 "Flying Fortress" engines as still another test to augment wind tunnel experiments gets under way.



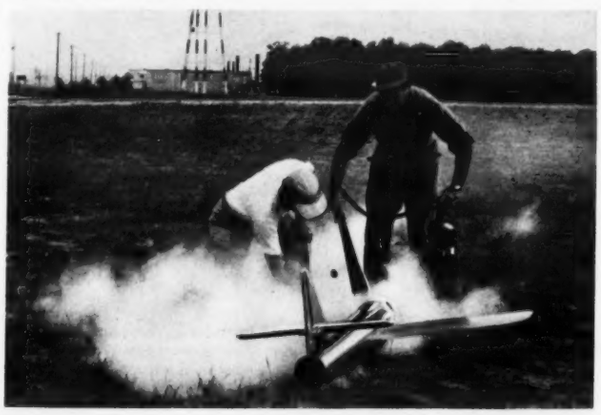
The Unit flies all sorts of models, including this helicopter.

which was four months in the making. It possesses a full set of flight instruments whose readings during tests are recorded on 16-mm film. The model is equipped with a 28-foot parachute and landing gear which emerges automatically as the chute is opened. Two general-purpose jet models have also been developed by the Unit. These high-speed designs are powered by pulse-jet engines similar to those fitted to the German V-1 buzz bomb.

Air Materiel Command's Dynamic Model Unit is doing a thriving business today. Engineers are busy at drafting tables lining the walls of one side of its hangar-like headquarters. Across the room is a well-equipped machine shop, with lathes, benches and other machines. The Unit's products, high-speed jets or egg-beating helicopters, often dot the sky over AMC Headquarters. And they are paying off for the Air Force in a big way.

This all-purpose jet model is capable of speeds up to 200 m.p.h. It is powered by a pulse-jet engine.

The jet exhaust beats up a cloud of dust as compressed air is used to start the model's engine. The airman at right stands by with fire extinguisher "just in case."



Minutes later the fire extinguisher has to be brought into play. The jet model caught fire in flight and fell in flames. In a full-scale aircraft the lives of the crew might have been at stake. Instead there was only minor damage to a scale-model. Within 20 minutes repairs had been made and the jet was flying again.

Model making begins with detailed drawing board plans. The midget takes six weeks to nine months to build—from drawing board to finished product. Instrumentation is designed as work on the actual model progresses. Some of the models cost as much as $25,000.

Actual birth place of the models is this workshop where latest equipment is utilized to produce the midgets. Cheap, expendable plastic replicas, like those being built in the foreground, are slated for high-speed tests which otherwise might mean destruction of expensive models.

Some of the models making up the Unit's "Air Force." In the process of being carried are two general-purpose jets.

USAF

To-morrow's Infantryman Depends on Air Force

What they aspire to be : Fully trained paratroopers of the 11th Airborne Division show modern techniques of an airborne invasion at Smyrna Air Force Base, Tennessee.

Because the aircraft greatly reduces the obstacles of time and space, the U.S. Air Force—as any other modern Air Force—is called upon to play a leading role in a type of operation which is expected to assume increased importance in any future war (though ultimately it is essentially "pedestrian"), namely, "airborne" warfare. The U.S. Army, in effect, is at present paying particular attention to the training of the paratrooper. Experience gained in the late war has indicated that airborne shock troops are destined to play a decisive part in any future conflict. But whilst the idea of glider-borne assault troops has been virtually abandoned, the paratrooper has been marked out as the infantryman of to-morrow.

The task of carrying the paratrooper to the actual point of operation will fall to the troop carrier formations of the U.S.A.F. At present most of these are equipped with Fairchild C-82 and C-119 "Packet" twin-engined, twin-boom transports. They are kept busy by the Army's intensive paratrooper training programme.

Each week approximately 200 men graduate from the paratrooper training centre at Fort Benning, Georgia. At present, the centre is training men with varied backgrounds, ranging from recruits to combat-tested master-sergeants and officers with years of experience who have volunteered for this duty.

Although the mission of the ground force soldier, "to close with the enemy and destroy him by fire, movement and shock action," has remained the same throughout the years, his method of entry has undergone radical changes with the advent of the large troop transport aeroplane. In effect, the Air Force's troop carrier formations now enable paratroopers to "close with the enemy" with minimum delay and maximum surprise. General J. Lawton Callins, U.S. Army Chief of Staff, recently underlined the importance of this development by stressing the following facts : (1) Parachute troops will play a major part in any possible future war ; (2) Much is yet to be learned about airborne warfare, and the Army will devote more time and study to it ; (3) The Army must improve the penetration power and some of its lighter weapons to support airborne operations and must solve numerous logistical problems in support of airborne troops.

Prospective parachutists arrive at the Paratrooper Training Centre, Fort Benning, Georgia, from posts and camps all over the United States. They have five weeks of intensive training ahead of them. Following graduation they become members of the 82nd or the 11th Airborne Division.

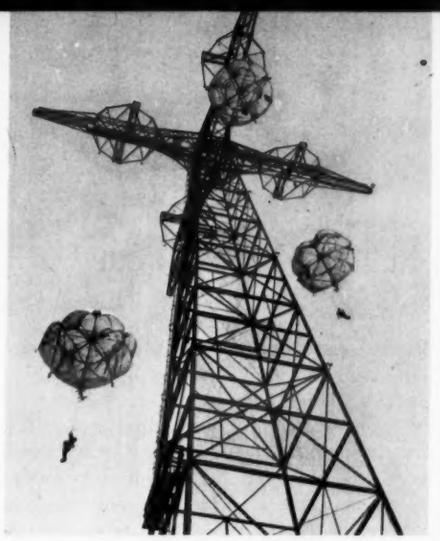
One of the important phases of the five-week training course are the daily periods of body-building physical training. Physical fitness and capacity is greatly stressed to the future troopers.

During the third week of the course, trainees are instructed on suspended harness rigs in the art of making body turns in the air and of guiding and manipulating the parachute during the descent.

During the same week of training, personnel jump from 34-ft towers—the top of which resembles the exit section of a troop transport aircraft—in harness and land in a pile of sawdust. The drop is about 15 feet before the slack in the suspension strap is taken up. In addition to instructing the correct method of leaving the aircraft, this type of training enables the men to get the "feel" of the jump.

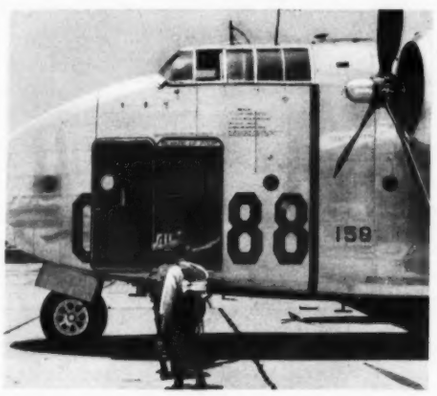
Nine years ago at Fort Benning, fifty men volunteered as the first test unit in airborne operations. Since that time over 125,000 men have qualified as airborne soldiers. More than 850,000 parachute training jumps have been made over the training area. During World War II the centre trained parachutists for the famous 82nd and 101st, as well as for the 13th and 11th Airborne Divisions of the U.S. Army. Many of these men played important roles both in the European and Pacific theatres of war.

Officers and men take the same course and are assigned to the same company. The training period is five weeks and includes instruction in such allied subjects as transportability of heavy equipment, flight rules and safety precautions, in addition to regular paratroop training.



First parachute drops: Before the trainees make any actual jumps from aircraft they gain experience in handling "captive" parachutes on the 250 ft. control-line tower. Shown here are three men being hoisted into position before their fall.

Next comes training on the 250 ft. free-fall tower shown in the back-ground. Trainees are hoisted up, then dropped with parachutes fully open. The trooper in foreground gets his first real-life landing lesson. Hours of instruction are devoted to this particular phase of training. Injuries requiring medical treatment are down to 1/10th of 1 percent. Bruises constitutes the majority of cases.



Paratroop trainees entering a Fairchild C-82 "Packet" transport prior to their first "real" jump.

The Great Event: Shown leaving the rear door of an Air Force Fairchild C-82 "Packet" transport are paratroopers making their first jump from aircraft in flight during the fifth and last week of training. Five qualifying jumps are made by each man, who also packs his own parachute. Instructors carefully inspect the packs, for the advice that "in case your 'chute fails to open, take it back to the quartermaster and ask for another" has proved unsound.

Fully equipped paratroopers being inspected prior to a practice jump.

A sky full: No large-scale military manoeuvre today is complete without paratroopers. During the operation an observer is able to identify the type of material being dropped by the colour of the parachutes. The paratroopers themselves most generally have camouflaged 'chutes; different colours, such as red, blue, orange, etc., indicates ammunition, radio equipment, weapons, etc.

The final day: Silver parachute wings are presented to the men in a formal ceremony marking the end of the five-week training period.

USAF

College Students Form Reserve Officer Pool

Today, as never before, college graduates have become a major source of officer material for the United States Armed Forces. College students are given an opportunity of undertaking officer training with the Air Force already prior to graduation. Upon completing four years of study, including military subjects and four six-week periods of Air Force training, they are commissioned as Second-Lieutenants for ground duties in the Air Force Reserve. Subsequently they may join the Air Force for a period of three years to train for duty as pilots, navigators, etc.

Undergraduate training takes the form of six-week summer camps with the AROTC (Air Reserve Officer Training Corps), which are organized at various Air Force installations throughout the country. Typical of these camps was the one held in 1949 at Orlando Air Force Base, Florida, headquarters of the 14th Air Force, which alone trained 400 such prospective officers last year. AROTC camps will again be organized during the coming summer.

Three students check in at the 14th Air Force six-week summer encampment for AROTC students at Orlando Air Force Base, Orlando, Florida.

Captain Richard B. Drane, instructor of Quartermaster Supplies Warehousing, explains to AROTC students the proper method of issuing clothing.

The course includes training in weapons and marksmanship. Here, students get carbine instruction under Lieutenant John Podraze (right), of Hazelton, Pa.

Much attention is paid to physical fitness. The picture shows S. B. Jones and C. L. Gilman engaged in a softball match. F. B. O'Neal, behind, acts as umpire.

Physical fitness training even during off-hours. Three cadets try the water of Lake Suzannah, near Orlando.

Military training includes exercises under field conditions. A Douglas B-26 attack bomber goes though a simulated strafing attack as Air Force ROTC students learn to "hit the deck." The attack was part of a two-day bivouac at Banana River, Florida.

Two AROTC cadets resting in their puptent after a march during their two-day bivouac at Banana River.

Fun comes in the evening. An AROTC "spit-and-polish brigade" practices on one of their number who will attend the blind-date dance organized by the Orlando "Evening Star."

A good time being had : a view of the blind-date dance in progress at the Orlando City auditorium.

USAF

Food is my Favourite Dish

"The way to a man's heart", asserts an old saying, "is through his stomach." "An Army," Napoleon is reported to have observed, "marches on its stomach." The stomach of an Army, Navy or Air Force, or rather what goes into it, therefore is of primary importance. It is literally true that without a continuous supply of adequate food to back them up, all military plans are without avail. U.S. Army Regulations put it this way: "Proper nutrition is of the utmost importance in maintaining the health, efficiency and morale of the troops. Gross deficiencies result in severe disease, but even mild nutritional deficiences, not recognizable by gross symptoms, may cause lack of stamina, decreased efficiency, lessened physical fitness, diminished resistance to disease, and may delay recovery from wounds and illness."

Unification of food

The ways which a large military force adopts to feed its hundreds of thousands of ever-hungry members therefore is a fascinating subject. A most instructive example is offered by the U.S. armed forces — first because the U.S. military establishment is surpassed in numbers only by one other (that of the Soviet Union), and secondly, because from the point of view of quality and quantity of food it is unrivalled anywhere in the world.

While the much-vaunted unification of the U.S. armed forces has not been very successful in the field of operational planning, as was recently revealed by the bitter controversy between the Air Force and the Navy, unification of feeding seems to be producing happy results. In effect, responsibility for the procurement of food for all three Services has been allocated to the Army. It is the U.S. Army's Medical Department which makes recommendations concerning food and feeding as they affect nutritional adequacy and the health of servicemen in the Army, the Navy and the Air Force. In turn, it is the Army's Quartermaster Corps which purchases, stores and distributes all items of food for the three Services.

A monthly Master Menu, which serves as a guide for each meal, is prepared by the Office of the Quartermaster General in collaboration with the Office of the Surgeon General of the Army. The Quartermaster Corps conducts schools for the training of instructors who serve in the Army Food Service Schools, and it prepares the courses of instruction, visual aids and other materials employed in such schools. It has inspection authority over Army food service activities and makes recommendations for improving food service schools and messes. The QMC has under way a broad program of research looking to the improvement of all types of foods and the development of improved containers, as well as the equipment used in preparation, service and preparation of food.

The preparation, serving, and conservation of foods, however, is a responsibility of the Army, Air Force or Navy commander, who appoints mess officers, mess stewards, cooks, bakers, and all others connected with food service in his organization. He is responsible for the kind of mess that is operated in his command. The standard of a service mess is set by the quality and variety of foods procured, and depends upon the interest, ability, and training of the food service personnel to whom the commander has delegated his responsibility for the preparation and service of the food.

You get fat in the Service...

Experience shows that during his first few days in the Service the average recruit eats more food than he does later on. The recruit may consume six pounds or more of food a day at first, but as soon as he becomes adapted to service life his food consumption drops to an average of around five pounds a day. The average soldier gains about five pounds in weight within a few months of Service regimen. The overweight recruit loses weight. His gains are in muscle and in sinew in exchange for fat, and his body posture is invariably improved after a few weeks of service.

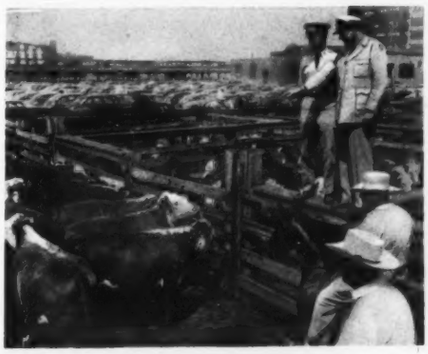
The amount of food authorized for one soldier for one day is what the Service calls a ration. There are various types of ration, each one determined by the conditions under which it is to be used: in posts, camps and stations where kitchens and refrigeration are available; in bivouac, where there may or may not be kitchens and where no refrigeration is available, or on military missions during which the men are separated from their kitchens.

Army regulations provide that the minimum nutrient intake per day for each soldier subsisting on garrison or field types of ration in areas of temperate climate shall consist of 3,600 calories and the following nutrient elements: protein, 100 grams; calcium, 700 milligrams; Vitamin A, 5,000 International Units; riboflavin, 2.2 milligrams; niacin, 16 milligrams and Vitamin C, 50 milligrams.

These standards apply to troops under average conditions of physical activity. In making nutritional evaluations of planned menus, the normal plate and kitchen waste of garrison and field rations is considered as averaging 5 percent of each nutrient. Therefore, for purposes of menu planning for temperate climatic zones, a serving of at least 3,800 calories is necessary to assure that the minimum standards of nutrient intake are met.

Depending on the type and degree of their activity and consequent expenditure of energy over periods exceeding one week, some troops may require dietaries of higher or lower caloric level than that described above. Likewise, troops of the "teen-age" group require a higher nutrient intake for growth in addition to normal energy expenditure. Dietary levels in such cases are determined by local medical authority.

Purchasing of fresh food the U.S. armed services, a $31,000,000-per month business, is accomplished by the Army Quartermaster Market Center System on a nationwide basis. Here Quartermaster veterinary and market specialists look over cattle in the Chicago stockyards prior to purchase. The officers are Captain Ritter and Captain John Knowles of the Quartermaster Corps.



Army food purchasing is carried out with the help of high-speed communications. Picture shows Army marketing specialists in the teletype room at Chicago headquarters. They are in contact with various market centres throughout the U.S.A. to compare meat prices.

The Market Center System supplies virtually all the perishable food required by the Army, Navy and Air Force. Purchases are made on a competitive basis from all over the country. Above: Mr. Roberts (right), fruit and vegetable marketing specialist for the San Francisco QMC, and Captain John Miller inspect lettuce in the field near Salinas, California.

The Garrison Ration

For purposes of maintaining standards of nutrition and computing costs, a selected list of 39 food items is designated the Garrison Ration. This list also serves as a basis upon which other foods of commensurate nutritive value may be designated to vary the menu. The Garrison Ration is composed of the following items and quantities:

Item:	
Meat	*Ounces*
Bacon	2
Beef, fresh	10
Chicken, fresh	2
Pork, fresh	4
Eggs, fresh	1
Dry vegetables and cereals	
Beans	.5
Rice	.6
Rolled oats	1.5
Fresh vegetables	
Beans, string, canned	3
Corn, canned	2
Onions	2
Peas, canned	2
Potatoes	10
Tomatoes, canned	2

Food prepared by girls as pretty as Betty Berger, above, *must* be good. She is explaining a step in the manufacture of cheese to Captain John Knowles, of the QMC Market Center System. The factory belongs to the Kraft cheese company. Place: Watkins, Minnesota.

Fruit	*Ounces*
Apples, canned	1.5
Jam or preserves	.5
Peaches, canned	1.2
Pineapple, canned	1.2
Prunes	.3

Early morning inspection of produce by a Market Center buyer, prior to purchasing for distribution to the armed forces.

"Sea food": Sergeant Matthew T. Barrow (left), of Madison, Maine, inspects fish prior to purchase at the Boston Fish Market.

Beverages	*Ounces*
Coffee, roasted	2
Cocoa	.3
Tea	.05
Milk	
Milk, evaporated	1
Milk, fresh	8
Lard	
Lard	.64
Lard substitute	.64
Butter	2
Flour, wheat	12
Baking powder	.09
Macaroni	.25
Cheese	.25
Sugar	5
Cinnamon	.014
Flavoring extract	.02
Pepper, black	.04
Pickles, cucumber	.16
Salt	.5
Sirup	.5
Vinegar	.16

The cost of the ration is determined by the basic cost of the food items that make up the standard garrison ration without adding any other expenses such as those incurred in procuring, shipping, storing, preparing, and serving the foods.

Like housewives everywhere, the U.S. Army has felt the impact of rising food costs during recent years. So that the soldier may be assured of ample, wholesome foods at all times, the ration cost is readjusted as often as changing market conditions require. The rising cost of the garrison ration, per man per day, from 1940 to 1948 is shown in the following figures:

1940	$0.4061	1945	$0.6162
1941	0.4386	1946	0.6331
1942	0.5099	1947	0.8040
1943	0.5642	1948	1.0302
1944	0.6096		

During the first six months of the calendar year 1949 the cost of the Garrison Ration declined from $1.0435 in January to $0.9791 in July.

27 Pounds of Meat, 48 Eggs a Month!

The food which is served daily to troops in the United States and overseas is consumed at three meals—breakfast, dinner and supper. The Master Menu used as a guide for the preparation of "Field Ration A" is compiled monthly in the Office of the Quartermaster General, Washington, D. C., and is distributed, six months in advance of the dates for which the menus are planned, to every mess in the United States. Because of local conditions and the possible unavailability of certain foods contained in a menu, substitutions are authorized. Illustrative of the Army menu is the following, taken at random, for October 12, 1949:

Breakfast

Chilled blended fruit juice — Ready-to-eat cereal — Fresh Milk — French toast — Hot Syrup — Bacon — Butter — Coffee.

Dinner

Parsleyed lamb patties — Browned potatoes — Buttered corn — Grapefruit, sliced orange, and fruit cocktail on lettuce — Salad dressing — Bread — Butter — Cherry cobbler — Coffee.

Supper

Roast beef with brown gravy — Mashed potatoes — Simmered greens — Bread — Butter — Chilled pineapple — Coffee.

As an illustration of the variety of foods served, the Master Menu for October 1949 contains 186 different items. There are :

20 kinds of meat and fish
6 kinds of bread spreads
16 cereals
29 leafy, green, and yellow vegetables
2 kinds of potatoes
14 canned fruits
12 fresh fruits
5 dried fruits

To mention a few but not all of the meat items for the month, each soldier is allotted :

1.77 pounds of bacon
9.80 pounds of carcass beef
.42 pounds corned beef
.14 pounds dried beef
2.25 pounds ham
1.05 pounds lamb
2.95 pounds chicken
.60 pounds liver
2.20 pounds pork loin
.6 pounds salt pork
.95 pounds sausage
1.50 pounds pork spare ribs
2.95 pounds veal

His share includes

48 fresh eggs
8.5 quarts fresh milk
6 pounds sugar
2.79 pounds butter
9 pounds bread
13 pounds ready-to-eat cereal besides a wide variety of other cereals.

The list is a long one and contains almost every type of food that is acceptable to a large section of the civilian population. Yet, some items that are relished by some soldiers may not appeal to others. Surveys have been made during recent months to determine which foods are least and which most generally acceptable. The studies covered meal patterns, food peculiarities, and the differences of individual preference due to age, sections of origin, family incomes and other factors. From the surveys it is expected that eventually a list of foods, perhaps not more than 125, will be determined as being nationally acceptable—that is, foods that are eaten by all the people in the United States. As a result of these studies, changes in dishes to be served may be incorporated in the menus and the present wide variety of foods may be reduced to conform with the choices the soldiers order from the serving tables.

Field buyers ascertain the availability of a food item and send the information to Market Center headquarters in Chicago, where quotations on the same commodity are collected from all over the country. Headquarters then wires buying instructions to the field buyers. *Left :* Quartermaster Buyer Captain John Knowles inspects the potato harvest near Perris, California. *Right :* Captain Knowles inspects the sacking and weighing of potatoes at the sheds of L.L. Tatum, Perris.

Operational Rations and Food Research

Troops engaged in combat or other missions which separate them from the kitchens of their units must depend upon what is called the "operational type" of ration. For obvious reasons these do not include any fresh or perishable components. Operational rations supplied during World War II, chiefly the "K Ration," the "C Ration," and the "10-in-one Ration," provided much experience for corrective improvement. Since the war, as a result of the research and development programme carried out by the Quartermaster Corps with the aid and cooperation of universities, industrial food laboratories, foundations, and other Governmental agencies, the Army learned much about operational rations and has made many important improvements in them.

Each member of the U.S. armed forces eats about twenty-seven pounds of various kinds of meat a month. Picture shows Buyer Captain Knowles (left) and an Army veterinarian inspecting a pork carcass at the Oscar Mayer Company, Madison, Wisconsin.

In connection with this food research programme it has been learned that environmental factors have an important bearing on a soldier's attitude towards food. These environmental factors include climate, topography and conditions of assault, support and survival. The sights, din and odors of battle are likely to affect the soldier's willingness to eat certain kinds of food and cause his inability to eat others. So also are the stresses of anxiety, fear, monotony, and fatigue.

Size and weight are matters of convenience which are not essential factors connected with domestic foods. But weight and bulk are extremely important in Army rations because of considerations of shipping space and because every ounce in weight added to the soldier's load decreases his battle effectiveness.

The elapsed time between production and consumption of processed military foods is a major factor in procurement and supply. While processed foodstuffs intended for civilian consumption reach the consumer within a few weeks after being shipped from processing plants, similar items for military use may be in pipelines of supply for as long as two years before they reach the kitchens. Military foods generally are shipped great distances, handled several times and stored under extremely adverse conditions. These factors require that military rations receive special attention in preparation and processing, as well as in packing and packaging.

The entire field of food and nutrition is covered in the Quartermaster Food Research Program. Results of the cooperative program are being realized in greatly improved methods of dehydrating various foods ; in canned meats which are increasingly nutritious, and in pre-cooked foods which will permit

"The finest food ever fed to any military organization..." Air Force Reserve officer cadets P.L. Caldwell, Harry Boehme, and Steve A. Carter at Orlando Air Force Base, Florida, seem to agree with the Quartermaster Corps' claim.

the housewife to prepare a complete meal in less than a half-hour. These are only a few of the improvements already achieved. Many more are under way which not only will contribute to further advances in food service in the Army but which, when available to civilians, will greatly relieve the drudgery of food preparation in the home. As research on meat items progresses hand-in-hand with industry's ability to produce, the number and variety of meat items capable of being served to troops can be increased almost indefinitely.

As the result of field tests, the accessory items in the new "5-in-one" ration have been adjusted in accordance with needs indicated by war and post-war experience. The number of fruit components and canned whole vegetables have been increased. Dehydrated items are eliminated.

The "C-3" Ration, containing 3,870 calories, originally intended only for brief periods of feeding, has been found by actual field testing to be sufficient for maintaining troops for a few days up to an extreme of three weeks. It has a variety of meat, fruit, and biscuit units, permitting considerable variation in the diet and the same time affording full nutritive value.

Procurement, Storage and Distribution of Subsistence

General Eisenhower, while Chief of Staff, stated that "food is part of the soldier's pay and none of it should be counterfeit."

To ensure that the soldier receives the finest foods that can be obtained and that the greatest possible economy is applied in the purchase, storage, and distribution of foods, the Quartermaster Corps maintains a well-organized supply system, manned by highly trained specialists who constantly observe every available market in carrying out the procurement program.

The purchase of military foods is under the general supervision of the Subsistence Branch, Supply Division, Office of the Quartermaster General in Washington. The program falls into two classes—the first dealing with perishable, and the second with non-perishable foods. Because of the differences existing between the two types of food in methods of handling, storage, and distribution, separate organizations are maintained for each of these two categories.

The Quartermaster Corps maintains purchasing offices in New York City and Chicago, with a branch at Oakland, California. Non-perishable food items are purchased at all three of these offices, though the bulk is procured through the Chicago and Oakland offices. All food-producing areas of the United States are covered in the purchasing program, so that anyone wishing to sell to the Army has the opportunity to do so.

The Subsistence Branch makes up procurement lists, based upon troop requirements and dispositions, for each type of non-perishable food that will be required to meet the needs of the using forces. To fill these requirements the purchasing offices from time to time issue calls for bids on the commodities desired. Bids must conform to the very rigid Army specifications in reference to food materials, methods of processing and types of container. The entire process is subject to Army inspection and to appertaining Federal laws and regulations. Awards are made to the lowest qualified bidders.

The program for purchase of perishable foods for military consumption is handled by the Quartermaster Market Center System. Directed from the field headquarters in Chicago and with ten market centers and eight field offices throughout the United States, this program, instituted as a necessity at the outset of World War II, has given to the Armed Forces a highly efficient, fast-moving, and economical method of procuring fresh foods. The Market Center program made it possible to standardize specifications. Rejections have been minimized; spoilage is reduced to an almost negligible quantity.

The Chicago headquarters is in constant communication with the Market Centers and field offices by teletype and telephone. Field buyers, experts in their particular lines who work out of their field offices, visit every important food-producing region at the time crops are at their peak and report on the availability, condition, prices and future prospects of each commodity. In this way the field headquarters is kept advised of market conditions and makes its decisions in ordering purchases. Although there is no formal bidding, each vendor is brought into competition with other vendors offering the same items or substitute items.

Working from the Master Menu, the field headquarters computes the over-all amounts of fresh vegetables, fruit, water foods, butter, eggs, cheese, meats and other perishables that will be required on a monthly basis. Requisitions from the posts, camps and stations are transmitted monthly to each market center. In addition to the Chicago headquarters, market centers are maintained at Columbia, South Carolina; Denver, Colorado; Fort Worth, Texas; Los Angeles and San Francisco, California; New Orleans, Louisiana; New York City; Seattle, Washington; and Richmond and Williamsburg, Virginia. The last-named center serves as the port for European shipments. Field offices are in Boston, Massachusetts; Washington, D. C.; Jacksonville and Miami, Florida; Kansas City, Missouri; Idaho Falls, Idaho; and San Diego and Bakersfield, California.

The field buyers time their schedules so that they will be on hand in production areas when the crop in which they specialize is in flush production. An office may be opened in a corner of a warehouse, in an upstairs store building or in a hotel room. A teletype and telephone are installed, a clerk or two engaged, and the Army's field office is in operation. The buyer's job is not only to hold down costs but also assure high quality.

The market center program has resulted in enormous economies. By purchasing in large quantities, important discounts are obtained. Shipping in carload lots reduces transportation costs. Inspection at points of origin eliminates rejections at posts, camps and stations. Centralization and organization holds communication costs to a minimum and personnel are most economically employed. A typical chain-store organization estimates the expense of procuring fresh foods to be two cents on every dollar expended. The cost of operating the Quartermaster Market Center System amounts to about 3.6 mills per dollar expended.

In the feeding of the Army the role of the Quartermaster Corps is like that of a wholesale dealer in civilian life. It buys, ships, and stores the food needed for Army consumption. Food supply at Army posts may be likened to the retail food store which dispenses food as needed. The Army unit which prepares, serves and conserves the food, is to the Army what the restaurant or housewife is to civilian consumers.

USAF

A W.A.F. Gets a Three-day Pass

Corporal Virginia Woodward hitches a ride in the Operations Room of Bolling Air Force Base, Washington. She was luckier than most three-day hitch-hikers in finding an aircraft visiting National Guard bases in the New England area, which enabled her to ride both ways with the same aircraft. Virginia was delighted. So were the crew.

During the flight to Burlington, Virginia was allowed in the "office" of the Beechcraft C-45. It was the third time she had been in an aeroplane.

Virginia waves goodbye to the pilot at Burlington Air Field, is greeted by her friends, Arlene O'Hare (right) and Jackie Malloy.

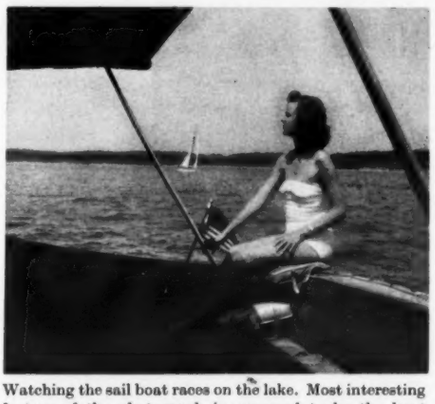
The W.A.F. ("Women in the Air Force") now form an integral component of the United States Air Force. At present the W.A.F. have about 2000 enlisted women and 300 officers, out of an authorized total of 4000 and 350, respectively. In peace-time they are employed in secretarial and communications work, photographic interpretation, motor driving and similar work. In case of war, however, the Air Force would recruit additional thousands of women as fitters, instrument mechanics and for work in hospitals, billets, etc. Peace-time W.A.F. members join up for periods of three to six years.

The pictures on these pages illustrate not what a W.A.F. does when she is on duty, but how she may spend her time when she is on leave. While pay in the U.S.A.F. is quite good, it does not allow for much extravagance. Cost therefore is an important factor. The problem was admirably solved last summer by Corporal Woodward, who spent a total of $17.95 on her three-day leave trip, including food, hotel, travel and shopping expenses.

W.A.F. Corporal Virginia Woodward, of Louisville, Kentucky, a research secretary with the U.S. Department of Defence in Washington, took advantage of the regulations which allow personnel of all three Services to occupy vacant seats on Air Force aircraft during routine training missions. From Washington she travelled to Burlington, Vermont, to visit her friend, Arlene O'Hare, and enjoy the scenery of Lake Champlain. Her programme included visits to New England landmarks, watching boat races, a theater performance, bathing and canoeing, tea on the lakeside.

The three spend a day cruising on Lake Champlain. Here they are on the bridge of s/s "Ticonderoga."

Inspecting some of New England's old relics during a visit to the University of Vermont's museum.



Watching the sail boat races on the lake. Most interesting feature of the photograph is supposed to be the boat in the background.

Attending St. Michael's Summer Play House at Burlington. Virginia and Arlene go backstage for actress Blanche Yurka's autograph.

Shopping for souvenirs completes the trip. Virginia spent $1.75 on mementos for herself and friends back home.

USAF

Air Force Keeps in Touch with Taxpayers

A formation of F-84 "Thunderjets" of the 33rd Fighter Wing flies over the sea off Cape Cod, Mass.

The U.S. Air Force is keenly conscious of the fact that the money it needs to maintain and expand its strength comes from the American taxpayer, via congressional appropriation. If Congress gets the impression that air power is not of vital importance, or that the Air Force is frittering away its money, it immediately slashes its appropriations. For this reason the Air Force maintains a more efficient public relations organization than any other military service in the world. In Washington, Air Force public relations are handled by a section of the Defense Department's public relations staff. In addition, however, each Air Force base has its own Public Relations Officer. It is the latter who supplies the local press with news and pictures describing what is going on at the base and who endeavours, by close personal contact, to show the civilian population that the Air Force is not merely having fun by streaking through the sky in gay abandon but is a hard-working, major component of the nation's military strength. The result is that the American citizen is better informed about and more directly interested in his air arm than any other national.

This is the pictorial story of an American citizen whose interest was aroused by the jet fighters he saw and heard as they flew from the nearby Air Force base and decided to learn something about their operation.

Calvin D. Crawford owns an hotel at Cotuit, on Cape Cod peninsula, a well-known summer resort region in Massachusetts. Last summer he called the P.R.O. of adjacent Otis Air Force Base, Falmouth, Mass., on the telephone and asked if he would be allowed to learn something of the operation of the Republic F-84 "Thunderjet" fighters operating from the base. "Come right over whenever it suits you," said the P.R.O. A few days later Crawford drove to Falmouth with his wife and daughter Ann, inspected the fighter unit there, and saw the day-to-day routine required to keep the outfit proficient in the flying tactics necessary to fulfill its mission in the air defence of the United States.

Crawford and his family learned that the noisemakers were the 33rd Fighter Wing of the First Air Force, and that this was one of thirteen fighter wings strategically located throughout the U.S. as part of the Continental Air Command. He was told that pilots of the 33rd have flown more than 10,000 hours during eleven months of operation with their F-84 "Thunderjets."

During the war Otis Air Force Base was used by the U.S. Navy for training and for anti-submarine patrol. It was returned to Air Force control in 1948, but it is still used jointly by the Navy for training missions by aircraft stationed at Quonset Point, Rhode Island.

Calvin D. Crawford, Mrs. Crawford and daughter Ann at Otis AFB. They are accompanied by Captain Royal E. Koons, a squadron operations officer, as they watch Technical-Sergeant Robert D. McGuirk fill the wing-tip tanks before Captain Koons takes off on a training flight.

Otis AFB weather forecaster Captain John C. Glasgow briefs Captain Koons before his flight. Accurate weather information is important for jets because of their speed. Crawford is listening to familiar language, for Cape Cod inhabitants are descendants of fishermen and traditionally still study the weather by means of barometers and wind indicators.

Back from his flight, Captain Koons explains instruments and controls of the F-84 to Ann Crawford. The helmet probably looks better on the head of the legitimate wearer.

Huddled in the engine compartment of an F-84, Sergeant Thomas C. Wenzel reassembles the air-conditioning turbine which provides warm air for the pilot in sub-zero temperatures eight miles up.

The Crawfords inspect the power plant of the F-84, an Allison J-35 gas turbine delivering 4,000 lbs. of thrust at 7,700 r.p.m.

Lack of hangar space makes it necessary to conduct inspections on the line in the open air. Here an engine is being removed for overhaul.

Night flying is one of the training duties of the 33rd Wing, as well as bombing and gunnery practice and interception, navigation, formation and penetration flights. Crawford was watching this F-84 before its night takeoff.

Next day Calvin D. Crawford tells his neighbours what he saw. Which shows that the P.R.O. at Otis AFB knew what he was doing when he asked the Crawfords over.

Sunshine and Cloud in U.S. Air Transportation

American Investment Bankers Report on 1949

Any report published in January on the collective performance of one branch of industry during the whole of the preceding year is necessarily incomplete, because it will be based on detailed results for only six or nine months of the period under review and on estimates for the balance. Especially in the field of air transportation, provisional reports cannot always be considered entirely accurate, because the cold season and its (hitherto) inevitable loss of revenue frequently upset even the most conservative calculations. The difficulty of precisely forecasting the operational results of the 1949 bad weather season is increased in the case of America's intercontinental operators particularly by the fact that the effects of Europe's currency devaluation of last September will have made themselves felt only in the last quarter of 1949.

In spite of these considerations of a fundamental nature, the 1949 report of the Aviation Securities Committee of the Investment Bankers Association of America deserves careful attention. The most striking feature of the report is that it does not attempt to perform miracles with figures that can not be substantiated but, on the basis of air transport developments during the past decade, makes a careful analysis of the tendencies apparent in 1949. This analysis permits certain conclusions for the future which in spite of eventual corrections to isolated monthly figures retain their validity.

On the whole, the American transport industry has reason to be happy about the results of the past year. Its victorious progress is graphically illustrated in a statement issued by the New York Port Authority announcing that the number of steamship Atlantic passengers at this greatest seaport of the world was exceeded by airline passengers for the first time in the month of October, 1949. A total of 21,700 passengers made the Atlantic trip by boat, whereas 24,300 passengers took the aeroplane. This is the most interesting single fact noted by the Investment Bankers Association.

Not without pride the Committee begins its 1949 account by recalling that its 1948 report had predicted the development of the industry during the past year with a reasonable degree of accuracy. At that time it listed four principal reasons for believing that the industry had turned the corner economically and had a relatively promising earnings outlook for the next two or three years. These were :

(1) The Government support required by the Civil Aeronautics Act was likely to be furnished.
(2) Increases in fares and reduction of costs were probable.
(3) Medium term growth in traffic was probable.
(4) A reduction in the then excessive competition was probable.

Government Financial Support

The certificated airlines are clearly entitled under the Civil Aeronautics Act of 1938 to sufficient financial support (mail payments) to permit them, if honestly and efficiently managed, to earn an adequate return on their invested capital—even though the mail pay may have to be high enough to contain a significant element of subsidy. There appears little likelihood that this section of the Act will be changed in the forseeable future.

The man who restored the balance sheets of the U.S. airline companies to health. *Joseph J. O'Connell, Jr.*, Chairman of the U.S. Civil Aeronautics Board, presided over the allocation of about $60,000,000 in air mail payments to the airlines in 1949. Allocations in 1948 were only about $35,000,000.

Thus, the extent of individual subsidies depends largely upon the discretion of the Civil Aeronautics Board. Ultimately, however it is dependent upon the attitude of Congress, which has to decide whether it will support the Board's rate decisions with the necessary appropriations.

Directly after the end of the war it was regarded as one of the principles of American economic policy that air transportation, being a branch of private economy, should develop by its own effort and would gradually have to learn to do without the Government's financial assistance. Accordingly, the domestic rate of mail pay dropped from $2.15 per ton-mile in 1939 to 55 cents in 1946. But soon it was discovered that this policy took no account of hard realities. It overlooked that air transportation still is in its infancy and that it is subjected to numerous unforseeable changes in flying equipment, route plans and frequencies of schedules. It overlooked, furthermore, that in the public interests the U.S. Government requires the regular airlines to conduct unprofitable operations (scheduled operation of lightly travelled services, availability of reserve seating capacity, etc.). The result of this policy was disastrous. With the exception of very few airlines in particularly favorable positions, the whole of the U.S. air transportation system found itself on the brink of ruin in the years immediately following the war.

In 1948 already the then Chairman of the C.A.B., James M. Landis, had recommended mail pay increases, and in 1949 the present C.A.B. Chairman, Joseph J. O'Connell, definitely adopted a new course of action, notably in view of the airline industry's importance to national defense. Under his guidance, total mail payments of about $60,000,000 were made available to domestic certificated carriers, trunk and feeder lines ; this represented an increase of $25,000,000 (71.4 percent) over the $35,000,000 paid in 1948.

The following table illustrates the evolution since 1939 :

Air Mail Payments For Domestic Trunk Routes

	Total	Per ton-mile
1939 (fiscal)	$17,000,819	$2.15
1946 »	$27,317,775	$0.55
1947 »	$22,064,565	$0.70
1948 »	$28,174,503	$0.84
1949 »	$54,958,000	$1.35

No change in this policy is anticipated by the Aviation Securities Committee for the immediate future. For the 1950 fiscal year it expects domestic trunk air mail payments to total $46,200,000, or $1.10 per ton-mile, to which probably will be added $15,000,000 for the feeder lines.

During hearings before the Senate Committee on Interstate and Foreign Commerce (Johnson Committee) it was argued in the spring of 1949 that present consolidated air mail payments should be broken down into a "service payment" and a "subsidy payment," which would enable the C.A.B. to be precisely informed on the nature of the assistance required by each operator and thus to draw conclusions as regards air carrier costs and efficiency. The C.A.B., on the other hand, requested that any such breakdown of payments should be postponed until a really adequate study of the problem, including a more accurate determination of the element of subsidy, could be made. The Aviation Securities Committee, too, warns against premature decisions in the present circumstances. It declares that such a measure

would probably react unfavorably on the position of the smaller, light-traffic lines whose mail payments contain a much higher element of subsidy than those of the large, dense-traffic carriers. For the benefit of the Post Office Department it points out that despite its allocation of subsidies the Government's losses on the air mail business over the past thirty years have been insignificant :

Post Office Air Mail Payments and Revenues, 1918-1947

Receipts from stamps on air mail letters	$539 million
Payments to airlines for carrying air mail	$405 million
Allocable Post Office Dept. overhead	$183 million
Total cost of air mail	$588 million
Deficit	$ 49 million

Increased Fares and Reduced Costs

The Aviation Securities Committee's advocacy of a generous subsidy policy should not lead anyone to assume that U.S. financial circles are gradually becoming sympathetic to the idea of a "cold nationalization" of the air transport industry. This would be far from the truth. The desire to see the airline industry established on a profitable basis runs through the entire report like a red line. On the principle that those who have shall be given the Committee puts forward the following suggestion :

"Mail pay might be allocated throughout the industry on a basis which would be most productive of efficiency, economy and progress by equalizing not the rate of return (net profit) but the opportunities and profits and losses. Under such a system, the most efficient carriers—large or small—might make really large profits, while others might merely break even or show losses."

What has been the major contribution in 1949 towards achieving higher revenues and reduced costs ? On the revenue side the earlier ambition of providing cheap air transportation at any price has now given way to a more sober realism. For years the airlines have been watching the Pullman railway fares on the assumption that everything would be well if only airline fares could be brought down to the level of Pullman fares. By 1946 the basic fares of the two modes of transportation had attained a point of close proximity. Today the problem of tariff reduction no longer is the focal point of interest. At the end of 1948 the basic air fare was raised from 5.5 cents to 6 cents per passenger-mile, but the expected sudden decline in traffic volume did not materialize. On the contrary, another record increase in passenger volume occurred in 1949, so that today the air transport system seems to be on the road to capturing about 50 percent of the combined rail-air passenger volume.

Air and Pullman Traffic, 1940-1949 (Million Passenger-Miles)

Year	Pullman	Air	Air Percentage of Total Air-and-Pullman Traffic
1940	7,243	1,052	12.7
1946	20,672	5,903	22.2
1947	13,516	6,011	30.7
1948	12,172	5,823	32.4
1949 (6 mos.)	5,622	3,170	36.1

This unexpected parallel development did not fail to influence the discussions on the projected expansion of air coach services. While it is clear that the coach tariffs of 4.0 to 4.5 cents a passenger-mile represent a strong attraction to potential travellers who not normally buy a standard "first-class" air ticket, it has also become evident that the new type of "second-class" air travel persuades a substantial number of passengers to change over from the "normal" air services (6 cents a mile) to the air coach services. The rise in passenger volume resulting from the introduction of coach services does not automatically cover operating costs, and the danger of a rate war in air transportation should not be underestimated. In any case, the C.A.B. exercises considerable restraint in its actions on applications for new coach services in 1949, an attitude which meets with the full approval of the Aviation Securities Committee.

The air mail services not merely serve as a milking cow for a few air transport operators. The public is given full value in return, inasmuch as everything possible is done to speed up the delivery of the mail. The picture shows a feeder helicopter carrying mail from the airport to the main post office of Los Angeles in half the time it would take by surface transport.

The reduction in operating costs made considerable progress during the past year, as is evidenced by the following table :

Cost per Available Ton-Mile (Domestic Industry)

1946	32.3 cents
1948	30.4 cents
1949 (9 months)	28.8 cents

At the same time, the break-even point showed an encouraging downward trend. While in the third quarter of 1946 the passenger break-even point was as high as 79.1 percent of the available seating capacity, the vital figure dropped to 64 percent in 1947, 54.5 percent in 1948 and 54 percent in 1949.

Air cargo traffic still constitutes a relatively small part of airline business. In the first nine months of 1949, the "Big Four" (American Airlines, Eastern Air Lines, Transcontinental & Western Air, United Air Lines) obtained only 4.12 percent of their gross revenues from this source, but they flew 10.7 percent of their total revenue ton-miles to obtain this revenue. Moreover, the rate of growth of total air freight traffic slowed considerably from the dramatic expansion of 1947-48.

*

In a single point of its 1949 forecast the Aviation Securities Committee was proved wrong by subsequent events : as yet there has been no sign of any reduction in present excessive airline competition. The history of the American railroads has shown that despite general agreement on the desirability of mergers, very few have actually been consummated. Airline mergers are even more difficult to achieve under present conditions, for the C.A.B. general increase in mail rates, which has restored the industry to financial health, has also removed the financial pressure for mergers from the weaker carriers. However, the Committee warns against granting powers to the C.A.B. to force matters, as this would undermine the stability of the industry and threaten its credit position.

The Problem of the "Greenbacks"

The Investment Bankers of America are not undividedly enthusiastic about the financing methods employed in the air transport industry. They express their opinion as follows :

"The present capital structure of many airlines appears unsatisfactory for a business subject to as many unpredictable fluctuations as air transportation. The proportion of bank loans and long-term funded debt appears far too high in some cases.

"Financing of flight equipment purchases through long-term debt seems unwise. The maturities of bonds and debentures should not,

Another means of stimulating the balance sheets is to create new traffic by introducing air coach services. An increase in seating capacity by about 30 percent and the elimination of food service aboard the aircraft made possible substantially lower tourist fares.
Left : A normal four-engined airliner (Trans Canada Air Lines).
Right : View of an air coach with 63 instead of 40 passengers, operated by P.A.A. on the popular San Juan—Puerto Rico—New York service.

in our opinion, run substantially beyond the time when the assets purchased with funds received from the sale of these securities are fully depreciated.

"The air transport industry as a whole, and certain companies in particular, are in need of substantial amounts of equity capital within the near future to refund bank loans and long-term debt, provide funds for the purchase of moderate amounts of modern flight and ground equipment and increase working capital.

"The industry's ability to raise this new capital will depend upon (1) the state of the securities market and (2) the assurance that the airlines will have substantial earning power over the next three years and real growth possibilities over the long-term future. The latter depends to a large degree on the continuance of constructive civil aviation policies by the U.S. Government."

There is no doubt that the security market's capacity of absorption for new commercial aviation issues depends on the general economic situation. Fortunately it is now apparent that last year-end's pessimistic outlook on the expected business recession was quite unjustified. According to the annual report of the Council of Economic Advisers to the President, America's national savings rose from $12,000,000,000 in 1948 to $14,400,000,000 in 1949. The large amounts of liquid money in the hands of private individuals and the low rates of interest in force at the beginning of the year have provoked an increasing tendency to invest in productive securities. The optimism on the New York stock market during the past few weeks is an excellent barometer of the general atmosphere. It will be the duty of the air transport industry to show the investing public in 1950 not only that it can produce profits with the assistance of Government subsidies but rather that it is gradually becoming a solid, safe field of investment.

"*Luftrecht*," by Otto Riese. — Published by K. F. Koehler, Stuttgart, 1949.

The second World War led not only to the exclusion, until further notice, of Germany from the circle of airfaring nations but also to a practically complete interruption of Germany's activity in the field of air law. Germany's trade literature of the post-war years produced nothing comparable to the textbooks written by Lemoine in France, Shawcross and Beaumont in England, Goedhuis in Holland. This gap has now been closed. The author, who has been teaching in Switzerland for many years, was a member of CITEJA, the international technical committee of air law experts, until its absorption in ICAO's Legal Committee. He took part in the conferences on fundamental air law problems in Warsaw, Rome and Brussels. At the end of 1949 he was elected to the chair of comparative private law at Lausanne University and simultaneously was invited to lecture on transport and air law. Thus he was well qualified to sift the voluminous material produced by the war and post-war years in the field of air law. The promulgation of the Swiss Civil Aviation Bill on December 21st, 1948, was the immediate reason for the publication of this work, the importance of which goes beyond that of a systematic presentation of existing Swiss or European air legislation. An exhaustive appreciation of international air law literature and careful treatment of highly topical, hitherto neglected problems (material rights in aircraft, irregular air services, etc.) stamp this volume as one of the basic textbooks on international air law. Clarity of language, logic of construction, and conscious limitation to the essentials of the subject, i.e., international law of civil aviation, make the book on Air Law by Riese one of the instruments indispensable to the theoretical or practical air law expert. (German.)

He.

Books Received

(Reviews of a selection to appear later)

Einführung in die Flugtechnik, by Dr. H. Rieck. — Published by Industrie- und Fachverlag Dipl. Ing. Rud. Bohmann, Vienna.

Le Problème de l'Etablissement des Laboratoires de Recherches des Nations Unies. — Published by UNO, Lake Success.

Publications scientifiques et techniques du Ministère de l'Air. — Distribution : Service de Documentation et d'Information Technique de l'Aéronautique, Paris :

No. 228. *La Recherche du Nuage Radio-actif*, by Hubert Garrigue.

No. 229. *Anisotropie, Symétrie, Hétérogénéité en Elasticité*, by André Brodeau.

No. 230. *Les Mesures de Température dans la Technique des Moteurs d'Aviation*, Pierre Vernotte.

No. 231. *Contribution à l'Etude des Pertes de Charge Singulières*, by C. H. Cottignies.

No. 232. *Souffleries à Eau*, by L. A. Sackmann.

No. 233. *La Fonderie des Alliages Légers et Ultra-légers*, by M. Caillon.

B.S.T. No. 111. *Le Point Astronomique à Terre, sans Instruments*, by Robert Genty.

Etudes Documentaires du S.D.I.T. — Distribution : Service de Documentation et d'Information Technique de l'Aéronautique, Paris :

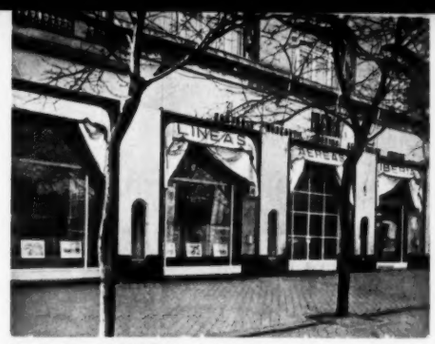
No. 24. *Le Refroidissement des Turbines à Gaz*, by J. Cornillon.

Airliners, by John Stroud (Puffin Picture Book 86). — Published by Penguin Books, West Drayton, Middlesex.

Ils Etaient du Prytanée, by Colonel Pierre Paquier.

Payload Factor 105 %

Spain's Airline System



Head office of IBERIA at 4, Plaza de Canovas, Madrid.

After years of hesitation, the United States today advocates the resumption of normal diplomatic relations with Spain. It should be noted in this connection that in the field of aviation politics Spain's ties with the world at large have never been broken, notwithstanding the country's formal exclusion from the International Civil Aviation Organization in 1947. And the Spanish national airline company is submitting balance sheets to the public which automatically provoke the question, "How the dickens do they do it ?"

César Gomez Lucía, Managing Director of IBERIA, who discovered the "Philosopher's Stone"—favourable balance sheets.

In a recent study entitled "Consideraciones Sobre el Balance de la Aviación Commercial" (Madrid, 1949), the Managing Director of the Spanish national airline, IBERIA, comments on the economic development of the enterprise he directs. Lucía, who had held an executive position already with IBERIA's predecessor company, known as LAPE and absorbed by the present airline some time ago, has no reason to lock worried. IBERIA has been very fortunate in the post-war years, and its operating figures merit being shown.

IBERIA Operating Results, 1946-1949

	1946	1947	1948	1949
Aircraft miles	1,785,910	2,226,890	2,708,300	3,394,910
Passengers	103,846	139,888	163,106	—
Freight (lbs.)	805,490	930,010	1,038,430	—
Mail (lbs.)	166,181	330,890	352,530	—
Passenger miles	—	—	61,826,500	73,646,500

As encouraging as this upward trend in operational results may be, it is not necessarily a characteristic of the Spanish airline company. Air transportation is making progress all over the world. Nearly all operators report increased operational results, but frequently they have had to learn the hard way that neither individuals nor whole organizations can live on rising performance curves. Miles and mails are not nutritious, the calories lie in the net profits. And in this respect IBERIA seems to have discovered the "Philosopher's Stone." In 1948 its net profit of 12,324,594 pesetas (about $246,000) amounted to more than one-third of the capital invested in the company. And with a total of 19,000,000 pesetas (about $380,000), the net profits for 1949 reached a record high of 60 percent of the investment.

The company's annual report points out that these profits were not obtained through subsidies paid by the government. Neither in 1948 nor in 1949 IBERIA received a single peseta in subsidies; quite on the contrary, it was able to make substantial refunds of subsidies paid to it prior to 1946.

Now IBERIA is no prodigy. Its air fleet is practically the same as that of a comparable Central European airline. It consists of the following aircraft :

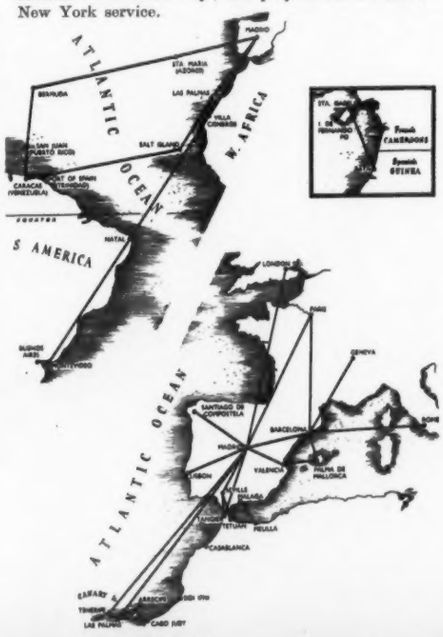
6 Douglas DC-4s (including two scheduled for delivery in February 1950 for the inauguration of the new Havana-Mexico City route) ;
12 Douglas DC-3s ;
5 Junkers JU 52s (for the Spain—Gold Coast service) ;
4 De Havilland "Dragon Rapides".

And the operational results of IBERIA are fully consistent, despite their constant increases, with the figures that can be expected from a company of its size both in the Old and New Worlds. For example, a comparison with Continental Air Lines in the United States discloses only minor differences between the two operators.

What, then, is the solution to this piece of sorcery ?

As paradoxical as it may sound, IBERIA operated its major air services with a passenger load factor of 105 percent. In a table listing the official operating results, which breaks down the payload factor according to individual routes, the trunk services between Madrid and Barcelona, between Barcelona and Palma de Mallorca, between Madrid and the Canary Islands, and between Madrid and Buenos Aires are shown to have obtained average payload factors of 94.15 percent, 96.56 percent, 89.34 percent, and 81.62 percent, respectively. In practice, however, these load factors were exceeded.

IBERIA's network of routes. On the Bermuda-Caracas leg additional intermediary landings are planned at Havana and Mexico City ; also projected is a Madrid—New York service.



Without attempting to make a detailed study of the Iberian Peninsula's earthbound modes of transportation, one may state that the reorganization of the railroad system since the Spanish Civil War has not achieved any very impressive results and that the 18-hour train trip from Barcelona to Madrid definitely does not belong to the major joys of life. The Spanish engineering and textile industries are concentrated in the Barcelona area, the Administration has its seat in Madrid. Any industrial executive, forced to consult the Government offices several times a week, prefers to make the trip by air in two hours, even if he has to ride in a Douglas DC-3 fitted to accommodate 22 or 23 passengers but actually carrying anything up to 27. He obviously would not expect to find a seat in such an aeroplane, but he prefers to stand up in an aircraft for two hours than for a whole day in the airless corridor of a crowded railway car. The same applies to the sea trip to the Canary Islands, which takes two days from Cadiz, whereas the aircraft only needs five hours from Madrid.

It is not surprising that the aeroplanes flying the Barcelona—Madrid service three times daily in both directions are always more than sold-out, that the seats on the domestic routes are always booked for months ahead and that the weekly South America service to Buenos Aires is fully booked three months in advance.

An additional factor is that on its domestic services (including those to the islands) IBERIA enjoys a monoply. The private company, Aviación y Comercio, which is controlled by shipping interests, is authorized merely to fly routes not contained in the operating plan of IBERIA and to help out the latter company in the event of excessive demand on its schedules.

To explain IBERIA's net profits you therefore don't have to believe in Santa Claus. The company makes money in the most normal manner, and does not feel embarassed about it. A French poet once said that money doesn't make you happy but it helps you bear your misery. It is to be assumed that in coming years IBERIA will appreciate having something in the kitty with which to renew its air fleet and expand its ground organization.

Surveying by Air

BY JOHN W. R. TAYLOR

An intrepid aviator named Nadar started air survey over 90 years ago, when he leaned over the basket of a captive balloon and took photographs of Paris which were used for map-making by the French military engineer Laussedat. His methods were undoubtedly more enthusiastic than scientific, and it was not until the arrival of reasonably stable aeroplanes during the 1914-18 War that air photography achieved much practical value.

Air Photography in World War I

Aircraft of the Royal Flying Corps took five photographs of positions behind the German lines less than six weeks after the start of that war, and within a few months had obtained sufficient good photographs to provide information for the first complete maps of the enemy's defences. More than 1,500 copies of these maps were distributed to units taking part in the successful Battle of Neuve Chapelle in March, 1915.

As a result of this success, the R.F.C. formed a proper photographic section under Lieut. Moore-Brabazon (now Lord Brabazon of Tara), to carry on the good work. It was for this unit that the first specially-designed air camera was produced in the Spring of 1915, by the Thornton-Pickard Manufacturing Company.

Before long, air photographs were regarded as an essential preliminary to every land battle, and by March 1918 well over ten thousand photographs were being taken weekly by the R.F.C. A new development in that year was the use of air photographs as a basis for accurate three-dimensional models of the whole Zeebrugge—Ostend area, on which were worked out details of subsequent Naval attacks on these towns.

By the time World War I ended, air photography for military map and model-making had become a highly-developed and successful art. This led to a widespread belief that it was the means not only of providing maps quickly, but so easily that the ground surveyor with his theodolite and painted stick would soon be things of the past. Unfortunately, air survey is not as easy as all that, as many hopeful ex-service pilots who invested their savings in an aeroplane and camera soon discovered.

Admittedly, air photography can produce an overall picture of any stretch of ground without much trouble, but there is a lot of difference between large-scale photographs taken at top speed for military intelligence purposes and the type of small-scale, extremely accurate photographic strips demanded by a civilian cartographer. Factors such as camera tilt, lens distortion and the basic laws of perspective can play havoc with accuracy. Similarly, it is little use having first-class photographs of a strip of territory if latitude and longitude cannot be positively located on the prints when the maps are made; hence, ground surveyors are still needed to fix the position of the area photographed in relation to the local grid. Weather, too, comes into the picture, literally, all too often; especially in some of the countries of Northern Europe, where there are few cloudless days each year really suitable for air photography.

Williamson "Eagle IX" camera installed in the nose of Hunting Aerosurveys' specially adapted Bristol "Freighter." On the right hand are the photographer's prone position and sight.

The complexity and expense of the work soon put the smaller concerns out of business, leaving only major ones like the Air Survey Company and Aircraft Operating Company (now Hunting Aerosurveys) in Britain, Fairchild and Abrams in America, together with a few smaller outfits run by men who are skilled surveyors as well as airman-photographers.

Development of peace-time aerial survey

These companies gradually overcame the technical problems, or reduced their effects to a minimum, and by 1930 most of them had evolved methods of air photography basically similar to those in use to-day. In spite of the urgent need for new maps for almost every development scheme throughout the world, they had a difficult job at first to persuade a sceptical government and local officials of the advantages of air survey. But patience and a high standard of accuracy achieved in small surveys of areas where ground survey would have been difficult, if not impossible, gradually

The Bristol "Freighter" which was used for recent high-altitude survey work in Iran by Hunting Aerosurveys at its operating base at Shiraz.

A vertical photograph of the area of London around St. Paul's Cathedral, taken by Hunting Aerosurveys. The ease with which bombed areas can be identified emphasizes the usefulness of such photographs for map revision or town planning, as well as for military intelligence.

won the day. For example, the pioneer work of the Indian Air Survey and Transport Company (now Air Survey Company of India) led to the Indian Government's decision in 1928 to adopt air survey exclusively for all future cadastral surveys. By 1939, this Company had in fact photographed no less than 200,000 square miles of India, Burma, Malaya and Sarawak, much of it completely inaccesible forest.

Progress was made in Africa too, by the Aircraft Operating Company. A geological survey in 1932 led to the discovery of a new and very rich goldfield in the West Witwatersrand district. Other jobs undertaken by this Company ranged from preparation of photographic maps (mosaics) of South African railway yards to large-scale mapping of the foothills of Mount Kilimanjaro for an irrigation project.

Middle East Expedition

The story of a recent survey undertaken in the Middle East by a leading British company gives a good idea of how the work is carried out, and the sort of difficulties that can be expected. It involved surveying and mapping an area of some 800 square miles, chiefly desert, in preparation for a new irrigation scheme.

As is customary, the personnel of the expedition were split into two parties. The first, which included two pilots, a ground engineer and three photographers, flew out to the operating base in the aircraft used for air photography. The other party, consisting mainly of ground surveyors, followed by air liner.

On this occasion the flying party was lucky, as it was based on a proper airfield, complete with darkrooms. As a result it was able to start work very soon after arrival. First task was to decide on the flight plan, which shows the path to be followed by the aircraft during photography. This plan normally allows for an overlap of 60 percent longitudinally and 20 percent laterally on each negative, to permit the use of stereoscopic instruments at the map-making stage.

The job of the pilots is to follow this flight plan, which is not as easy as it sounds. The flight path has to be calculated carefully to ensure that the aircraft is not blown off course by wind ; the pilot has to make sure that his machine remains precisely on this course at a

Vertical air photograph taken by Air Survey Company for an irrigation project in the Middle East. Ground survey of such an area would be an extremely lengthy and costly business, and would seldom reveal the details apparent in such photographs.

One of the surveyors taking a trig. bearing, with the enthusiastic but dubious help of natives, during the recent Hunting Aerosurveys expedition to Iran.

Photographers belonging to the Iran expedition trimming prints and eliminating local opposition with an insecticide spray. The chap in the foreground seems to be suffering from a headache.

steady speed and height and with no variation in lateral trim, which would produce "tilt" in the photographs. The actual runs over the target are normally controlled by an auto-pilot, but the pilot still has to ensure that conditions are just right at the moment the auto-pilot is cut in.

In the case of this particular expedition, photography was carried out at heights varying between 6,000 ft. and 12,000 ft., permitting scales of from 1 : 2,500 to 1 : 10,000 for the finished maps.

Meanwhile, the ground party had arrived and begun to establish the precise position of ground control points, to ensure accurate orientation of the maps. They were not so fortunate as the flying party, as their work involved days of uncomfortable travel by jeep over stretches of trackless desert. Instead of comfortable brick buildings, they had to sleep and work in tents and native mud huts, with scorpions and the dangers of a cholera epidemic to add to their troubles, not to mention goats which wandered in and out of the huts at will and seemed to thrive on a diet of maps and sheets of carefully-worked out calculations.

Most of the actual surveying had to be done between the hours of 4 and 7.30 a.m., because of the heat haze that developed later. This left the rest of the day free for the surveyors to do their involved calculations, and reestablish trig. points marked on previous days, by putting up fresh black and white chequered flags to replace those "borrowed" by natives for making shirts. A few words with the local gendarmerie removed the need for this after a time.

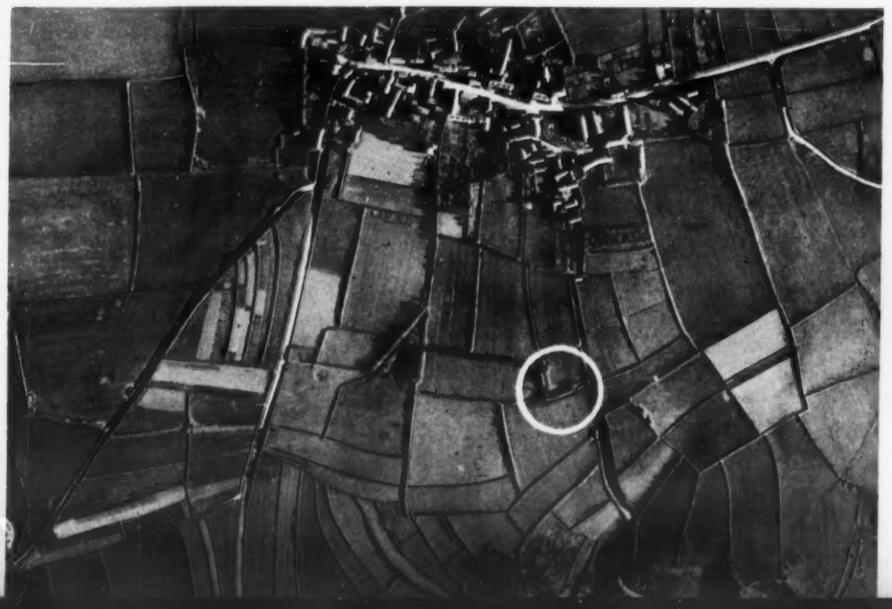
In case this gives the impression that ground parties are the only ones who have to endure such trials and tribulations, it may be worth recording that another flying party from the same company recently had to operate from an airstrip frequented by tigers and other unpleasant animals. As a result, the only native cook who would agree to share their tents was a character who was usually too drunk to notice the beasts. In the end, his cooking became so bad that the pilots decided to prepare their own meals between flights.

In spite of all the difficulties, the whole operation in the Middle East was completed in ten weeks, and the films sent back to the company's laboratories in England for the complex and highly-skilled process which eventually produces the finished maps. An idea of the importance of this part of the job can be gained from the fact that air photography accounts for only some 15 percent of the total work required to produce a map by air survey methods. Nevertheless, it enables accurate maps to be completed in one-fifth of the time and at much less cost than doing the same job entirely on the ground.

Developments in World War II

Although most developments in air photography between wars were pioneered by civilian companies, the importance of its military applications were by no means

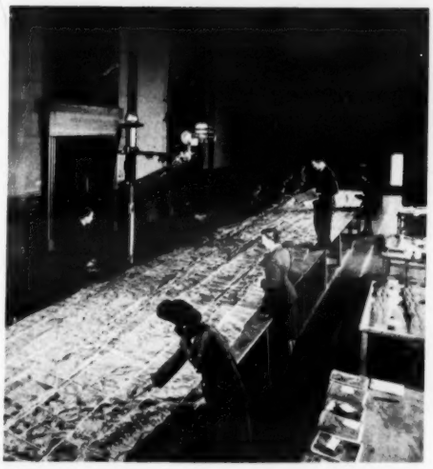
A "Spitfire" fighter discovers German radar installation : *Left :* Two small circular objects (in circle) photographed by a "Spitfire" in France on November 22nd, 1940, aroused suspicions that the Germans might be using radar. *Right :* A low-level sortie over German-occupied territory by another "Spitfire" three months later confirms these suspicions. A typical example of air photography in military operations.



neglected. In fact, Colonel-General Baron von Fritsch remarked in Germany in 1939 that "the next war will be won by the military organization with the most efficient photographic reconnaissance." It was ; and even if air photography did not play quite such a decisive part in achieving final victory as von Fritsch had predicted, there is no doubt that air photographs were a vital requirement in the planning stage of almost every action on land, at sea and in the air.

During the war, new high-speed, high-altitude aircraft were evolved specifically for photographic-reconnaissance duties. Radar control was brough to a fine art. Multiple film processing and printing plant was installed in mobile vans, so that photographic maps and intelligence pictures could be produced in forward areas within a few minutes of the return of PR aircraft. And precision mapping equipment such as the Multiplex machine was developed, to bring entirely new standards of accuracy to mapping from air photographs.

After VJ-Day these and other benefits of wartime experience were passed on to the civilian companies, whose pre-war personnel had provided the trained nucleus around which the World War II military PR organization was built up. They opened up immense new possibilities. For example, civil air surveys could now be carried out at heights up to 24,000 ft., without the cameras—or their operators—icing up. The advantages of this are obvious. To photograph an area the size of Great Britain from 20,000 ft. requires some 11,000 exposures with a 6 in. lens camera : photography of the same area from 5,000 ft. would require 16 times that number of exposures.



Women's Auxiliary Air Force personnel making up a "Mosaic" from air photographs preparatory to the production of a map of enemy installations.

Aerial surveying has thus advanced in 35 years from a military novelty to an exact science ; but it is far from being dull and unromantic. For instance, as photographers were developing some of the Middle East negatives, they saw a number of regular lines appearing across the face of what should have been parched, empty desert. Prints were made and the outlines of a long-lost city became visible, complete with a palace, gardens, houses and harem. Nothing was visible from the ground ; in fact camel tracks passed right over the foundations of once-proud walls. Only the all-seeing eye of the air survey camera had been able to wrest the secrets of the lost city from the sands.

Who Wants a Ghost Ship ?

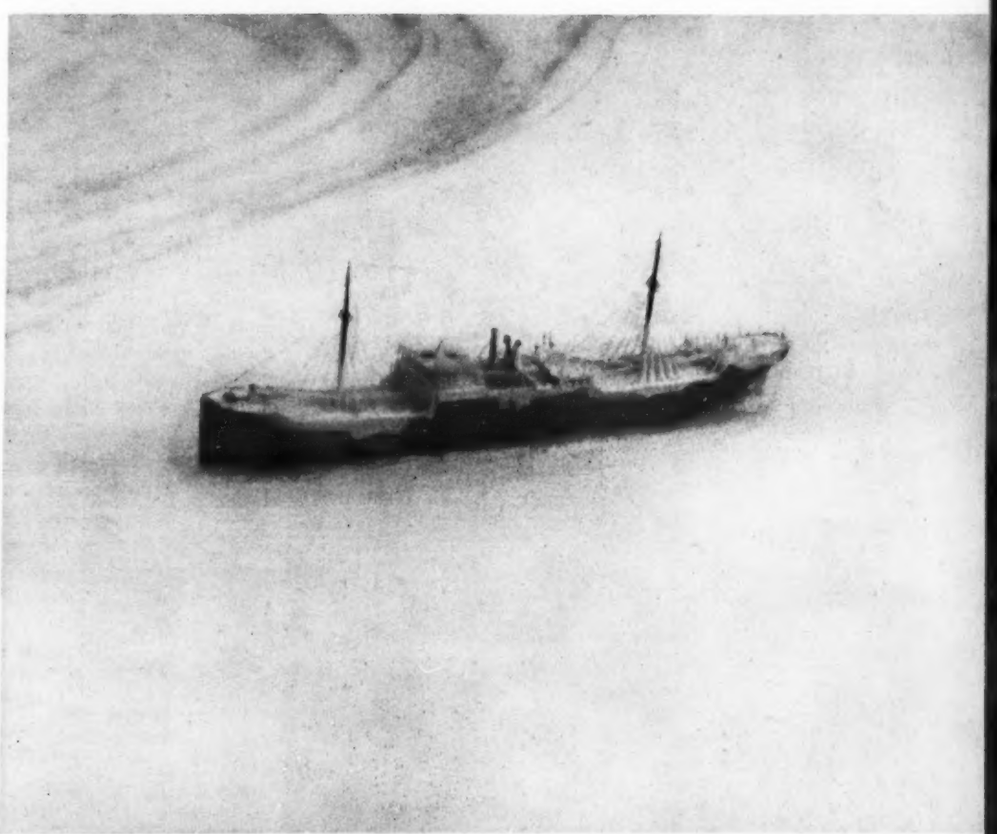
An Avro "Lancaster" four-engined reconnaissance aeroplane from 408 Photo Reconnaissance Squadron of the Royal Canadian Air Force, based at Rockcliffe, Ontario, was peacefully winging its way on ice reconnaissance in the middle of January when suddenly the captain of the aircraft, Flying Officer D. E. Biden, of Moncton, New Brunswick, called out to the navigator, Flying Officer D. W. Carr, of Hamilton, Ontario. "What's *she* doing down there ?," he said, pointing downward. The navigator craned his neck and looked out. He saw a steamship of approximately 10,000 tons, fast in the ice off Mansell Island, near the entrance to Hudson Bay, and apparently abandoned.

The vessel was lying less than 100 yards off the northwest shore of the island, her bows pointing in a northeasterly direction. Flying Officer Carr dipped the nose of his "Lancaster" and circled the ship at nearly mast height. The decks were sheathed in ice and there was not a sign of life aboard. However, the general appearance of the ship gave the impression that it had not been abandoned for a great length of time. The crew were unable to discern any name, flag or other indentification.

The "Lancaster" crew made an immediate radio check with the radio station of the Canadian Transport Department's ice-bound outpost on Nottingham Island, about 80 miles away. Nobody on Nottingham could give a clue to the ship's identity nor any information concerning a vessel recently in trouble in the area. Having done what they could to establish that assistance was not required, the intrigued "Lancaster" crew turned away and proceeded on their mission. They made a full report to Royal Canadian Air Force Headquarters on their return to Rockcliffe air base.

Air Force Headquarters at Ottawa had no record of any vessel of such size having been abandoned in the area, and a report of the discovery, together with serial photographs, has been submitted to the Department of Transport.

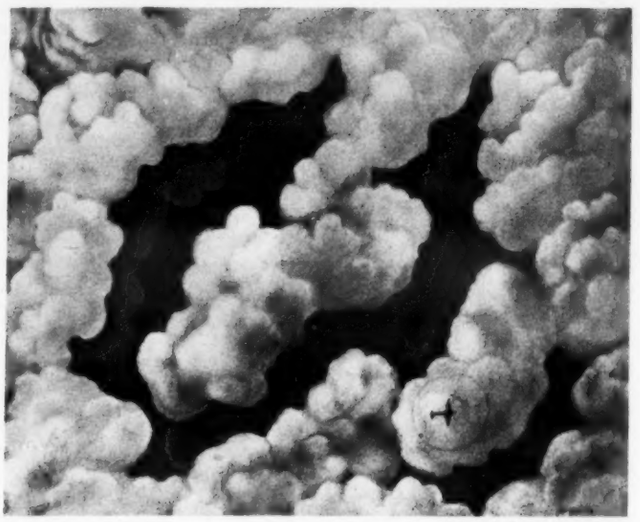
Who wants the ghost ship ? The address is, as indicated, 100 yards off the northwest shore of Mansell Island, Hudson Bay, Canada...



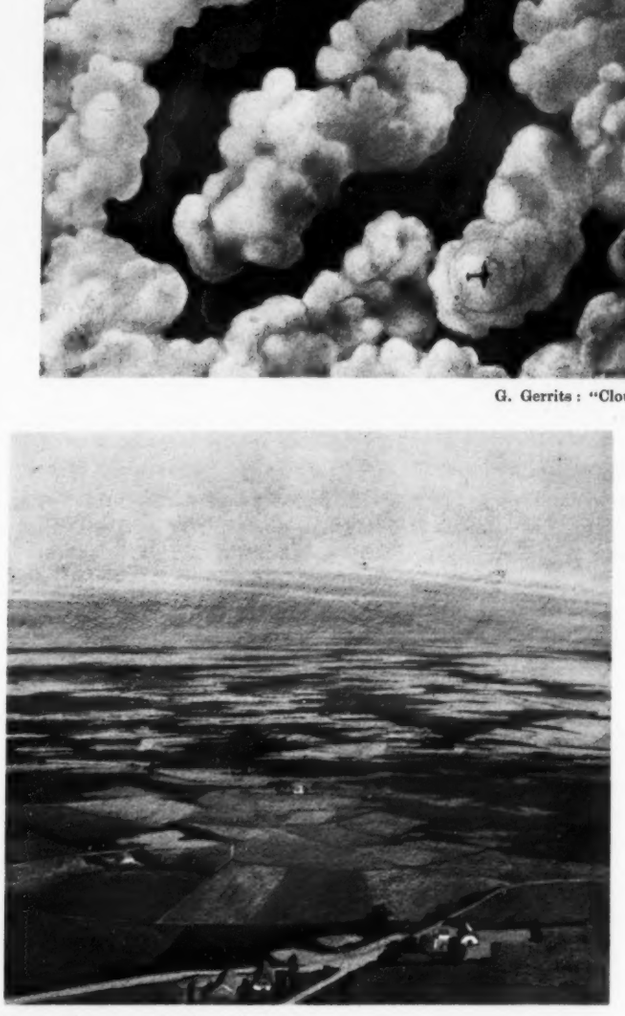
G.P. Adolfs : "Amsterdam."

Flying Artists

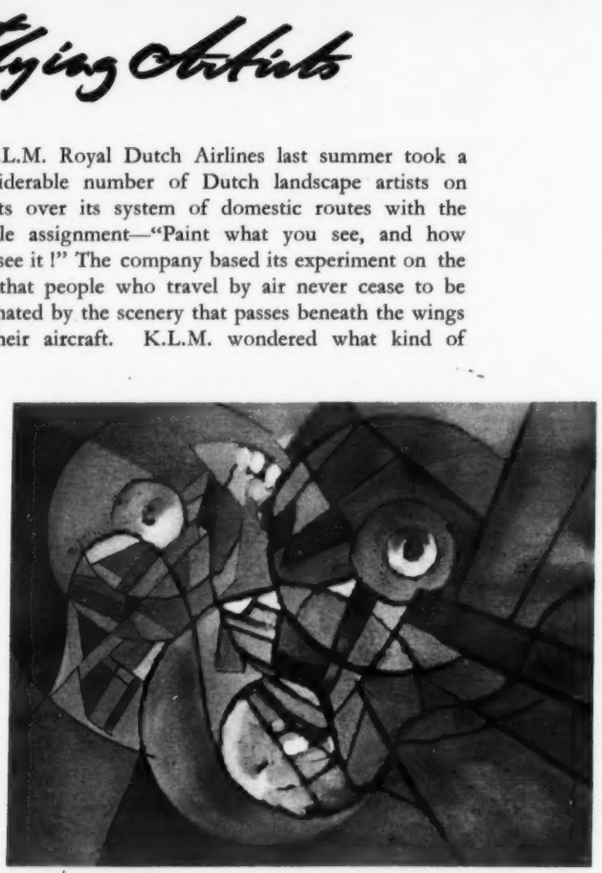
K.L.M. Royal Dutch Airlines last summer took a considerable number of Dutch landscape artists on flights over its system of domestic routes with the simple assignment—"Paint what you see, and how you see it !" The company based its experiment on the fact that people who travel by air never cease to be fascinated by the scenery that passes beneath the wings of their aircraft. K.L.M. wondered what kind of impression such aerial landscapes would make on the artist.



G. Gerrits : "Clouds."



G. van Bruggen : "Landscape."



J.P.F. Kraus : "Flight."

A. Breetvelt : "Landscape Impression."

In cooperation with the official Dutch Association of Artists (even they seem to have a trade union !), applications for these flights were invited. Painters who sent in their names were first of all supplied with a number of aerial photographs to study. Then they had to make a few sketches based on the impressions they gained from the photos. These sketches were judged by a special committee. Finally, all entrants were given a chance to fly with K.L.M.

Sixty paintings were ultimately chosen from a very large number submitted for display at an exhibition. Practically every trend of modern art was represented. Last November the public was able to see the results of the experiment at the Amsterdam Municipal Museum, where the sixty selected paintings were placed on show. Five samples are reproduced on this page. We suspect that full-colour prints would produce an even more striking effect.

Wilful Misconduct and the Warsaw Convention

BY ALAN GOODFELLOW, LONDON

International air transportation would be impracticable if airline operators found themselves faced with widely differing local legislative rules and regulations every time they landed in another country along their routes. In order to achieve a standardization of the major points of air transport legislation at an international level, the airfaring nations in 1929 concluded the Warsaw Convention which, among other things, regulates the airline operators' liability for injury and damage which may be caused to passengers and freight shippers in the event of transport aircraft becoming involved in an accident. Efforts are now being made to bring this Convention up to date. Commander Alan Goodfellow, lawyer and former British naval aviator, Legal Adviser to the International Union of Aviation Insurers, has consented to discuss the draft of the revised Convention which is to take the place of the Warsaw Convention of 1929. —*Ed.*—

The revision of the twenty-one-year old Warsaw Convention has now reached an advanced stage in the deliberations of the Legal Committee of the International Civil Aviation Organization, which has inherited the work of the old C.I.T.E.J.A. Few international lawyers will deny that the latest revised draft, which is largely due to the devoted work of Major K.M. Beaumont, London, over the past five years, represents a very great improvement on the original Convention. That is not meant as a criticism of the existing Convention which, despite certain defects in draftsmanship, has been one of the outstandingly successful international Conventions and has been ratified by practically all the leading States of the world (with the regrettable exception of the Latin American Continent). The old Convention has worked remarkably well and has given rise to very little litigation. Nevertheless it had defects, especially in connection with the documents of carriage, its doubtful application in the case of charter agreements and its lack of a definitions clause. All these defects have been remedied in the new draft ; in particular the burdensome clauses which require unnecessarily complicated documents of carriage and impose unfair sanctions on the air carrier for purely technical breaches of the requirements have been swept away.

It remains to be seen whether the new Convention, when the draft has been finally agreed, will find acceptance on a basis not less wide than the existing Convention. This is obviously a vital point, and in this connection the views of the U.S.A., which is responsible for more than half of the total commercial aviation of the world, are of vital importance.

There are two points which may give rise to difficulty. The first is connected with the limits of liability. When the Warsaw Convention was first sign, civil aviation was in its infancy, and a maximum liability of 125,000 francs, representing at that time £1000 sterling, was fixed as being a reasonable limit. No one would contend that such a limit is reasonable today, having regard to the increased cost of living since 1928, but fortunately the draftsmen were wise enough to link their limit with the French *gold* franc. The result has been that successive devaluations of the currency of the Contracting States have automatically increased the limits, so that in the United Kingdom, for example, the limit for death or personal injury has now risen from the original figure of £1000 to a figure of nearly £3000. Unfortunately, from the point of view of international agreement on this subject, the U.S. dollar remains at its pre-1949 level, whereas the U.S. cost of living has risen, with the result that the present limits of between $8000 and $9000 may well seem inadequate to a country which is used to thinking in terms of big figures and has grown accustomed to very large jury verdicts in Common Law actions for death or injuries. On the other hand, there are many Contracting States in which the present limits equal or exceed the amount which would be likely to be awarded by the court in a successful action based upon proof of negligence. If international agreement is to be achieved, some compromise is essential, and it is to be sincerely hoped that the U.S.A. will accept the existing figures as representing a reasonable compromise, the more so since any increase in the figures might well jeopardize the chances of acceptance of the new Convention not only by additional States, but even by some of the present Contracting States.

There remains one other thorny problem, namely, the question of the unlimited liability which attaches to the carrier on proof of "dol," either by himself or by his employees. From the outset this subject (Article 25 of old Convention) proved a difficult one, owing to the fact that there was no exact translation of the term "dol" in the languages of many of the Contracting States. The solution ultimately adopted was to make the article applicable to cases of dol "or such default as, in accordance with the law of the court seized of the case, is considered to be equivalent to dol." This resulted in some startling anomalies. In the British and U.S. versions of the Convention "wilful misconduct" was substituted for "dol," while in the Scandinavian countries it was turned into "gross negligence." Neither of these substitutions, and especially the Scandinavian one, really represented the same thing as dol, which implies some element of bad faith as between the carrier and his customer.

It should be noted that under the old Convention unlimited liability applies not only in the case of dol, wilful misconduct or gross negligence—as the case may be—of the carrier, but also of such conduct on the part of his employees, *including those in charge of the aircraft.* This has given rise to the difficulties which might have been anticipated, namely, attempts by passengers and their relatives to recover unlimited damages either by actual proceedings or by threat of proceedings based on the alleged fault of the crew, the members of which are usually killed in the accident and are therefore unable to defend themselves. Where, as is sometimes bound to happen, the damages which would have been recoverable at Common Law exceed the Convention limits, there is an obvious temptation to adopt this practice, especially in countries where the legislation does not enable the defendent to protect himself against the high costs of an action by making a tender or payment into court of the Convention limits. There is an equally natural temptation to a jury to assume wilful misconduct or gross negligence on the part of the crew from the known circumstances of the accident, especially when they know that the damages awarded will not have to be paid by the crew or their estates, but by the air carrier, who has almost certainly insured his liability. In the result there are many cases based on Article 25 pending in the courts of the Contracting States at the present time, with every indication that the number will increase.

One solution would be to increase the Convention limits, but this would only be a partial solution since whatever limits are fixed there must still be cases of hardship where the damages recoverable at Common Law would exceed any limits which might be fixed by the Convention. An increase in the limits would merely increase the cost of air travel and would benefit the imprudent traveller at the cost of the traveller who was prudent enough to protect his dependents by insurance.

An alternative partial solution would be for all the Contracting States to agree to introduce into national legislation a system similar to that of the United Kingdom, where the defendant has the right

to make a payment into court. As from the date of such payment the claimant is put at his peril as to the costs of the action and if he fails to recover more than the amount paid into court, he will not only have to pay his own costs but the costs of the defendant as well. This is an obvious deterrent to the bringing of speculative or vexatious actions.

The compromise at present adopted in the latest revised draft is to use the following words : —

> "The limits of liability comprised in this article shall not apply if the claimant proves that the damage was caused by an act or omission of the carrier, or of any official of his acting within the scope of his employment, committed with knowledge that it was wrongful, and intentionally foreseeing its probable consequence, or recklessly, without regard to such consequences" (Article 14 [9]).

The important difference between this and article 25 lies in the fact that the expression "officials" is defined as : —

> "The board of Directors of a company or corporation, the partners in a partnership firm, the General Manager, or other person or persons in a similar position, entrusted with the control or management of the Carrier's business. It does not include pilots or other members of the operating personnel of aircraft, or members of the ground staff who are not entrusted with the control or management of the Carrier's business."

This wording is not entirely satisfactory. It presents difficulties in translation into the French language, which will probably be the official language of any new Convention, and includes several expressions which have shades of meaning and may be differently interpreted by the courts of different Contracting States. Many of those concerned in the business of air transport, and in particular many American aviation insurers, consider that any escape clause of this nature, however worded, must to a large extent nullify the effect in limitation of liability. They would like to see the clause deleted entirely, and as a pratical claims lawyer I have considerable sympathy with their view. On the other hand, the international jurists of many countries feel that it would be contrary to natural justice and public policy to give the air carrier the benefit of limited liability in cases where dol can be proved. As an international lawyer myself I feel that there is much to be said for their point of view also.

The new wording suggested does at least cure one serious defect of the present article 25, in that it does not make the air carrier responsible without limit for the acts or omissions of his employees other than senior executives. On all logical grounds this change is to be commended. It may be quite right that if the carrier himself is guilty of bad faith towards his customer, by employing an aircraft which he knows to be unairworthy or a pilot whom he knows to be unqualified or incompetent, he should be liable without limit. It is totally illogical that the same position should hold good where he himself has taken every reasonable step to ensure the safety of the aircraft and its contents, but an accident occurs owing to the failure, however serious, of some competent and fully qualified employee such as the pilot or navigator over whom he has no effective control at the time. In the course of a flight many circumstances are liable to arise in which an instantaneous decision must be made by the captain of the aircraft. Such decision may prove to be a wrong one and may result in a disaster for which the decision is held to blame. Sitting in safety on the ground and examining *ex post facto* the known circumstances of an air disaster, it is easy enough to blame the pilot or the navigator, the more so since it is true that by far the largest proporation of air disasters are due in a greater or lesser degree to failure of the human element. It is easy also for a sympathetic jury to feel justified in finding that the assumed wrong decision comes within the definition of dol or wilful misconduct or gross negligence, especially when the damages are not going to be paid by the person responsible or out of his estate. It is difficult for a lay judge and jury to put themselves mentally in the seat of the pilot, flying perhaps in darkness or cloud at say, 500 kph or more, faced with the necessity of a split-second decision on which the safety of himself and all souls on board may depend. It is not right or logical that the liability of the carrier should be increased because the human element in a trusted and capable employee fails in an emergency. As between the carrier and his customer there has been no element of bad faith to justify such a result.

There will no doubt be eminent international jurists who will disagree with this viewpoint and who will argue that proof of dol or its equivalent by any employee taking part in the contract of carriage should result in unlimited liability on the part of his employer. I can only say that I can find no logical argument in support of this view. Unlimited liability on the part of the employee and his estate, perhaps yes ; unlimited liability on the part of the carrier, who has been guilty of no act of bad faith to his customer, no. The old principle of *qui facit per alium facit per se* has no application where dol is concerned. I have written above of the necessity of compromise on the question of the limit of liability if international agreement is to be reached on a wide scale. On this point also, if such agreement is to be reached, and if broad justice is to be done as between the carrier and his customer, some compromise on the lines suggested in the new draft appears to be essential.

On January 5th the Legal Committee of the International Civil Aviation Organization met at Taormina, Sicily. The author of the above article, who attended the meeting, had written his contribution with an eye on the forthcoming event. Subsequently he informed us that the Committee had no opportunity of dealing with the Warsaw Convention but limited its discussions to the Rome Convention. Unlike the Warsaw Convention, the Rome Convention of 1933 (and the Brussels Protocol of 1938) did not regulate the liability of airline operators towards their passengers and air freight shippers but laid down their liability for damage caused by their aircraft to third parties on the surface (e.g., in the event of a house being damaged by an aircraft crashing on it, of a passer-by being injured by an aeroplane about to land, etc.). However, the revision of the Rome Convention involves basically similar problems to the revision of the Warsaw agreement.

The Author wrote from Taormina as follows :

"There is not very much to tell you about the ICAO meeting, I'm afraid. They are going on for another four days, but it is pretty certain that they won't touch anything except the Rome Convention this time. The main issue has been the deadlock between North America and several other countries as to the basis of liability. The Americans want it to be subjective (i.e., subject to proof of negligence) while the rest want it to be objective (i.e., automatic and absolute).

"At Montreal the USA offered to compromise by accepting the Warsaw Convention basis (i.e., subjective, but with the onus of proof shifted onto the defendant to show that the accident was unavoidable). This was decisively rejected. At Taormina they have made another attempt to find a compromise solution on the basis of *(a)* objective liability up to certain limits, followed by *(b)* subjective liability up to much higher limits on proof of negligence, followed by *(c)* unlimited liability in respect of intentional damage, any compulsory insurance to be in respect of *(a)* plus *(b)* only. This has been accepted as a compromise, subject to final agreement on the limits.

"The figures at present purposed are 100,000 gold francs for gliders ; 250,000 gold francs for light aircraft up to 2,000 kgs ; 600,000 gold francs for medium light aircraft up to 6,000 kgs, increasing by 100 francs per kilogram for larger aircraft up to a maximum of 6,000,000 gold francs. It is proposed that limits for subjective liability should be three times those for objective liability. This would give insurable limits of 300,000 gold frs. (about £6,000) for gliders ; 750,000 frs. (about £15,000) for light planes ; 1,800,000 frs. (£36,000) for medium lights ; £70-75,000 for the mediums, reaching the maximum of 18,000,000 frs. (£360,000) at an all-up weight of 60,000 kgs. Whether the aviation insurance market can absorb such limits at anything like economic figures remains to be seen.

"On representations made by the Fédération Internationale Aéronautique, the limits for gliders and light aircraft were reduced, otherwise they might both have had to carry insurance for 1,800,000 gold frs. (£36,000) for all international flights or contests, as was originally proposed."

The "Globemaster II" on its first flight, 27th November, 1949.

On its two decks the enlarged fuselage of the C-124A accommodates about 200 fully-equipped troops.

Globemaster II

Of all the large transport aircraft of the U.S. Air Force, the Douglas C-74 "Globemaster" is probably the least publicized model. Its prototype emerged quite suddenly just after the war. A limited production series of fourteen machines was built, and for about three years it has been used on regular Military Air Transport Service flights in the United States, across the Atlantic, to Panama and to Puerto Rico. This military duty does not greatly resemble the career that originally had been mapped out for the "Globemaster." In effect, the civilian version of the type, designated Douglas DC-7, was expected to leave a marked imprint on the post-war commercial air services and completely overshadow its smaller predecessors, the Douglas DC-3 and DC-4 (the DC-6 was then regarded merely as a transitional design). Things turned out differently.

The U.S. Air Force obviously is happy with its "Globemasters." Were this not the case, it hardly would have ordered a new series of thirty aircraft of an improved and enlarged version, the Douglas C-124A "Globemaster II." The first machine of this series started its flying trials in November 1949.

No longer forced constantly to keep in mind the aircraft's possible future adaptation to commercial air transportation, Air Force and manufacturers jointly evolved a "Globemaster" having every characteristic of the all-round utility which is expected from a vehicle specially designed for the transport of equipment, ground vehicles and troops. It has a very large loading compartment, which can be divided according to requirements, and a complex system of loading and unloading aids.

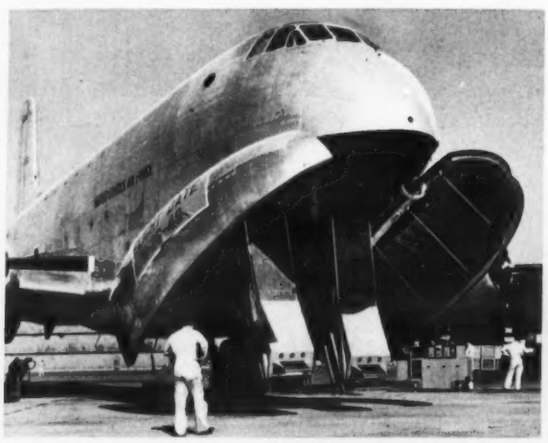
The fuselage is not circular in section as was considered desirable in the predecessor type for purposes of cabin pressurization. The fuselage width is approximately the same, but its unobstructed height has been increased from 8 ft. 6 in. to 12 ft. 10 in., which made possible the installation of a dividing floor and, thus, a 100 percent increase in seating capacity. In this form, the "Globemaster II" is capable of carrying about 200 fully-equipped soldiers; as a hospital aircraft it will accommodate 160 stretcher cases and 15 attendants.

The greater fuselage height also permits transportation of heavy military vehicles and their loads. For loading purposes, the C-74's floor hatch and elevator is inadequate for the new model, although it sufficed to hoist jeeps and similar equipment into the cargo hold. In the C-124 the whole fuselage nose has been designed to be free of obstructions so that mobile equipment can be driven aboard like through a barn door. To the fuselage portion ahead of the wing, below the upper deck reserved for the pilot and his crew, a deep "belly" has been added, which contains a ramplike downward extension of the cargo compartment floor. In place of the nose wheel well (the nose wheel, which in the C-74 retracted forwards and upwards, it hauled up rearwards in the C-124) the entire lower half of the fuselage now forms a large loading area which in flight is closed by two clam-shell doors. Two bridge-type ramps, each about 3 ft. wide, extend from the sloping cargo compartment floor to the ground when the doors are open; consisting of three hinged sections, the two ramps are withdrawn zig-zag-fashion into the fuselage and are ready for use directly after landing.

This arrangement saves an enormous amount of time in the loading and unloading of cargo during intensive supply operations. A small, fully-loaded motor truck convoy of about 50,000 lbs. total weight can be driven straight into the cargo hold via the extension ramps and the inclined cargo floor. While they are being tied down, the ramps are pulled in and the clam-shell doors closed, and the aircraft is ready to take-off. A fuel supply of 11,000 U.S. gals. permits the "Globemaster II" to fly non-stop for 2,000 miles, or roughly from Gander to Shannon; alternatively it could fly the 850 miles from Shannon to Berlin, unload in the latter city, and return to its point of departure without refueling.

Cargo loaded via the extension ramps in the fuselage nose is stowed away...

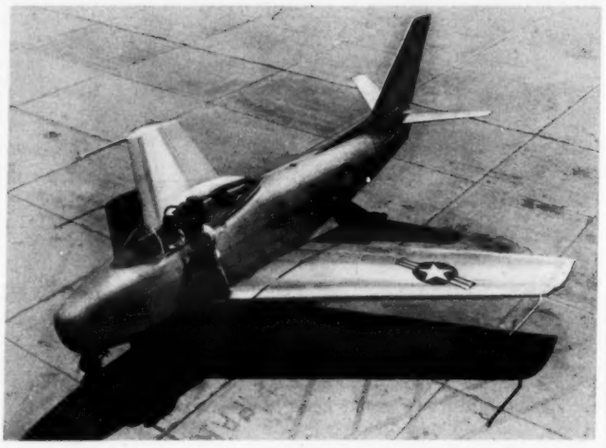
...while the ramps are withdrawn...



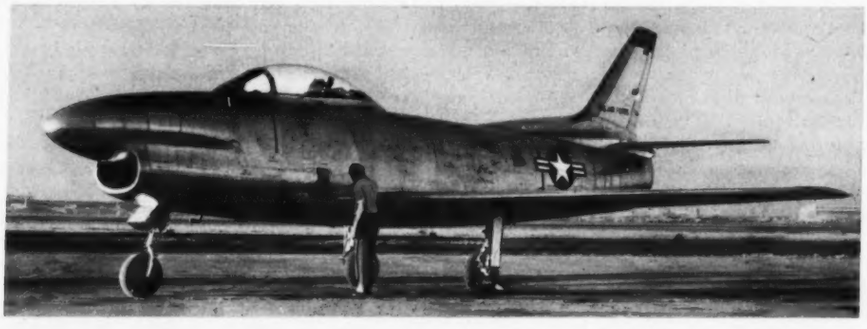
...but remain ready for immediate use directly the aircraft lands.

Progress in Pictures

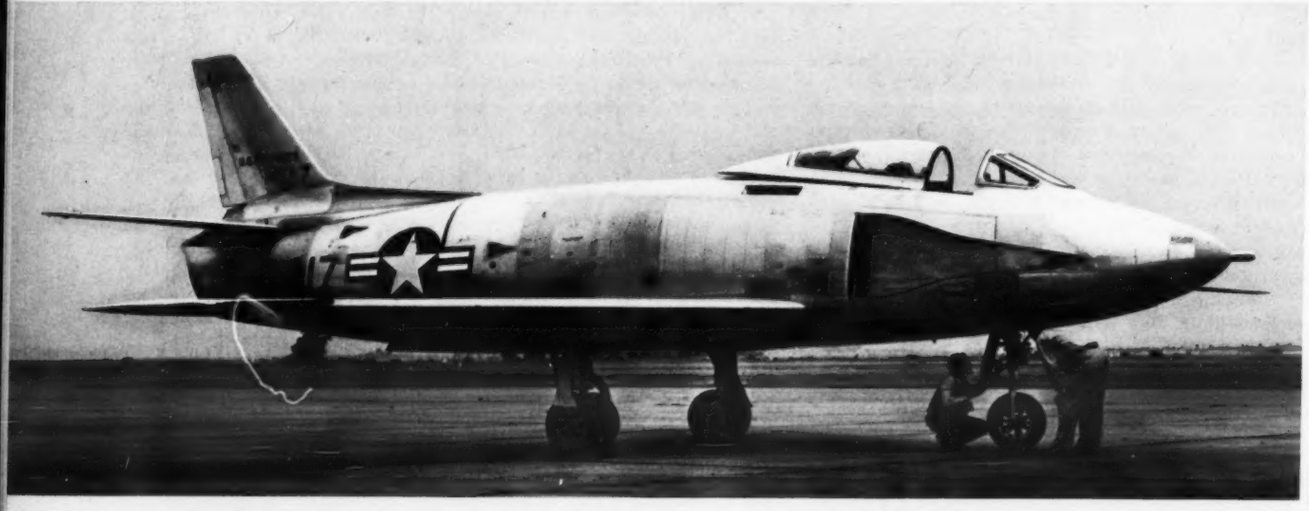
Is progress speeding up its pace ? Just over two years have passed since the prototype of the *North American XF-86 "Sabre"* jet-propelled fighter made its first flight. That was on October 1st, 1947. In the following spring the first production model, the F-86A, was completed, in the autumn the type set a new world's speed record of 671 m.p.h., a year ago it entered into squadron service with the U.S.A.F., today it is one of the Air Force's standard jet fighters. Already two more powerful experimental developments are undergoing extensive flight tests. The first, designated *North American YF-86D,* has an afterburner for short-period thrust increase ; it made its initial flight on December 22nd, 1949. A month later the second development, the *YF-93A,* originally designated F-86C, took the air. Its span is somewhat greater, and its fuselage has been lengthened by 6½ ft. Whilst the F-86A and the YF-86D are powered with General Electric J-47A axial-flow gas turbine engines of 5,200 lbs. static thrust (more than 6,000 lbs. with water injection), the YF-93 has been equipped with the new Pratt & Whitney J-48 to 6,250 lbs., which is a model built to the basic designs of the British Rolls-Royce "Tay" engine featuring a centrifugal compressor; the YF-93, too, is equipped with afterburners. — In both these developments of the "Sabre" provision is made for the installation of radar search equipment or heavy armament in the fuselage nose. The question of the engine air intake, which in the original version is in the nose, therefore became something of a headache : in the YF-86D the intake was lowered and set farther to the rear, whereas in the YF-93 there are two intakes located flush in the fuselage sides.



North American F-86 "Sabre."



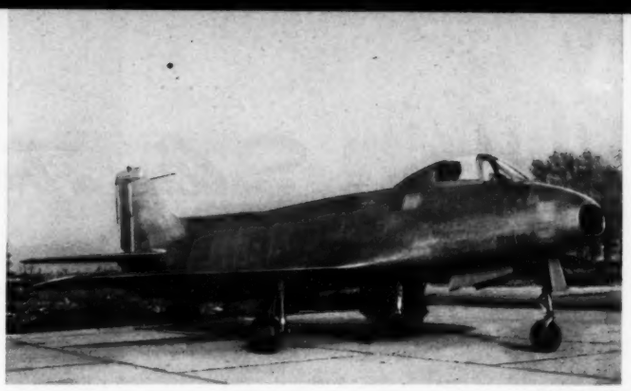
North American YF-86D.



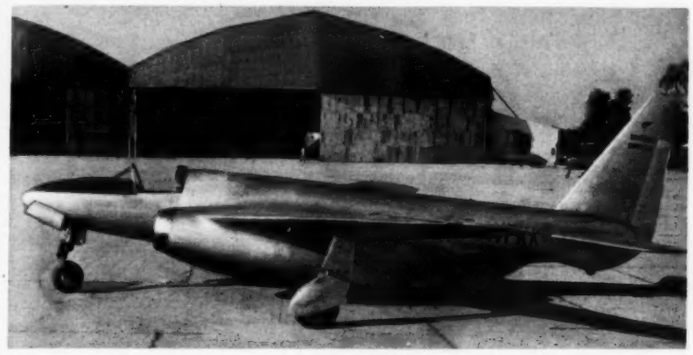
North American YF-93A.

Not particularly graceful but obviously of considerable utility is the new Sikorsky H-19 "two-storey" helicopter of the U.S. Air Force. It features a boxcar-shaped loading compartment measuring 10 ft. by 5½ ft. by 6 ft. for cargo or 10 passengers ; above this is a separate cockpit for the pilot with large windows ; in its blunt nose the machine has a readily accessible Pratt & Whitney R-1340 radial engine of 600 h.p. The engine power is transmitted via a shaft running backwards and upwards at an angle of 45 degrees, plus a special gear mounted aft of the cockpit. A civil version, designated S-55, has just been completed. It somewhat resembles a small city bus, and it would seem that with this new design Sikorsky has brought the realization of helicopter passenger services between airports and residential or business areas into the tangible future.

Three French jet-propelled prototypes have started their flight-test programmes in the past few months. In September, 1949, the *Arsenal VG 90* shoulder-wing monoplane made its first flight. Carrying radar equipment and armed with three 30-mm cannon, it is intended for aircraft carrier operation. Another carrier-borne type is the *Nord 2200*, the wings of which have a pronounced sweep-back. The shape of the wing root seemsto indicate thorough aerodynamic studies. Like the "Espadon" of S.N.C.A. du Sud-Ouest, which was exhibited at the Paris Aircraft Show, the two types have a gross weight of about 18,000 lbs. ; a Rolls-Royce "Nene" gives them a maximum speed exceeding 560 m.p.h. at sea level. Lighter by about 4,000 lbs. is the *Nord 1601* jet-propelled experimental aircraft, whose two Rolls-Royce "Derwent" engines are mounted under the mid-wing mainplane close to the fuselage. The wing is strongly swept and tapered. Maximum speed is said to be at least 625 m.p.h.



Nord 2200.

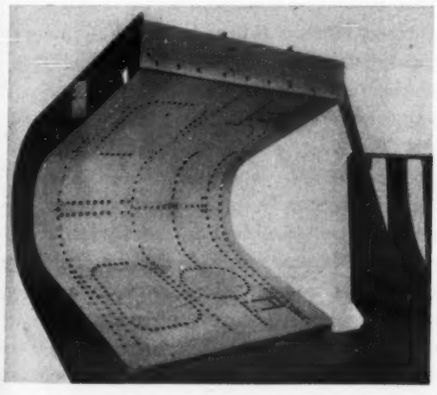


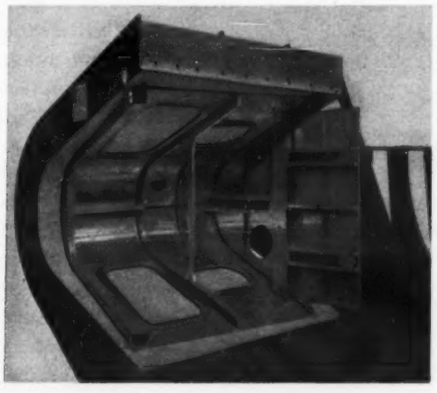
Nord 1601.

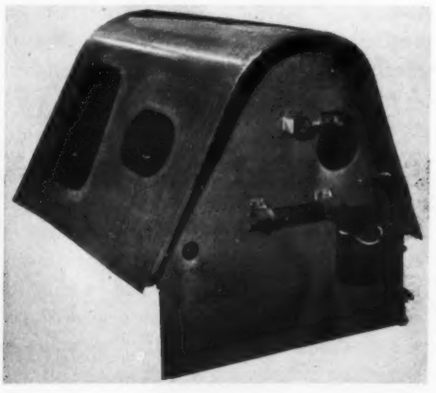
Arsenal VG 90.

In order to brake the landing run of fast jet-propelled aeroplanes, use has been made in several cases—e.g., in the Bell X-1 supersonic experimental aircraft—of parachutes stowed in the tail and releasable by the pilot directly after the touch-down. Today's picture shows not only such a test being made with the new Martin XB-51 three-jet light bomber but also the design of a modern ribbon parachute. From the apex of the latter is suspended the small pilot parachute which withdraws the main canopy from its pack.

"Monocoques are no monocoques" may describe the methods hitherto employed in the manufacture of aircraft structures. Although in this manufacturing method the skin is the stressed component of the combination and the members riveted onto it on the inside serve as stiffeners, it is usual during the production process to fit the stiffening members together on a jig, so that they form a skeleton and subsequently to rivet the metal skin onto them, just as if it were a mere fabric covering. Other means are employed in the new *Fairey production method*. In a fixed envelope jig of stout metal sheet (left) the skin of the aircraft is first given the proper form, within a margin of one-thousandth of an inch ; the rivet holes are then drilled, and the internal structural components riveted on. Where a rib or former does not fit accurately into place, it is modified by the fitter (centre). The result is that even semi-skilled labour or a variety of subcontractors will furnish uniform and, hence, interchangeable structural elements (right), which greatly facilitate final assembly. Should the design office require modifications during the period of development or quantity production, including modified stiffeners, additional supports for installations, etc., these can be fitted without changing the outer skin.







Selling a Transport Aircraft

BY A SUCCESSFUL AIRCRAFT SALESMAN

The Unknown Factor of What is Needed

If it were possible to write a book on "How to Sell a Transport Aircraft," it is quite probably that the first chapters would be devoted to something entirely different. They would probably be entitled "How to *Make* a Transport Aircraft," since an examination of all the problems involved shows that design and construction of the aircraft should not be commenced before a comprehensive market survey has been made and a sales policy decided upon.

Ever since what we delight to refer to as planned selling began, be it for commodities or proprietary articles, the world's most successful sales organizations have always based their planning on certain known facts and factors. The sugar manufacturer knows exactly what percentage of the population in his various sales territories calls for lump or granulated sugar, and he would not attempt to market lumps in a "granulated territory." The manufacturer of textiles can tell you almost exactly the periodical changes in demands for woollens or worsteds and the territories where it would be futile to try and sell rayons or silks.

But then people have been consuming the same sort of sugar in very much the same sort of quantity and for the same reasons for a long time, and—if the edicts of fashion are ignored—the use and consumption of textiles has altered very little in the last half-century.

Transport aircraft are, however, a much more complex problem, due to two factors : first, the fast-moving advance of science and the resultant effect upon operations ; second, the unfortunate fact that—whether we like or not—it takes the best part of five years from the start of design of a transport aircraft to its introduction on main line routes, during which time it may well have become to a large extent obsolete.

Thus it is that the aircraft manufacturer is forced into a combination of guesswork, makeshift and adaptation of existing design. Very much the same applies to power plants. The engine manufacturer always will try to point out to the aircraft designer that he should have several years of warning as to what will be asked of him. The aircraft designer, on the other hand, will finally have to compromise with existing engines—at the risk of being accused of building an aircraft around an available power plant instead of calling for the right engine to power his machine. But then again, the design, type testing and the thousands of hours necessary for "de-bugging" an engine before it can be really installed in an aircraft with full confidence may well be of the same order as the time required for the design and development of the airframe.

The Nightmare of Sales Planning

Thus it is inevitable that sales planning for any transport aircraft becomes somewhat of a nightmare. Very often the cry is heard that if we would have the aircraft of our dreams available in three or six months' time, then selling would be child's play compared with what it is under the conditions now imposed upon it.

Any aircraft sales organization therefore has to plan sales either on something it has not got, i.e., an aeroplane under development which will be available only in several years' time, or on something it has got but which may become obsolete by the time the potential customer receives it.

In a no more fortunate position is the airline executive who, as the manufacturer's brother in distress, somewhere has his own crystal-gazing department which tries to work our traffic potentials, passenger requirements, schedule speeds, maintenance organization, Government subsidies, mail contracts and all the other unknown factors. All these things the executive is supposed to forecast accurately to an avaricious Board of Directors.

Such, then, is the background for the would-be aircraft sales planner, and if he is in any way over-burdened with enthusiasm, this may well be damped at the outset by statistics and statements of people who are "supposed to know" and who state almost categorically that no more than two or three hundred aircraft are required to operate satisfactorily all the lines at present scheduled in the world : a statement which is, of course, in direct contradiction to the fact that many more than that number of Douglas DC-3s alone are operating at present.

Painstaking Preparations

Thus it is a fact that the first points of interest emanating from any attempt at market research are the existing fleets of operators and the uncontrollable factor of inter-changes of aircraft, sometimes even before they have been put into operation, between the various operators.

It has been said that a successful aircraft salesman must be a combination of technician, accountant, international financial thug and society playboy ; whether this be true or not, considerable versatility is called for.

After securing the services of such individuals, the manufacturer will have to determine the territories to which he should confine his sales energies ; alternatively, he will have to decide—at the risk of watering down his sales potential—to cover the whole world. A third solution would be to select various territories for major effort and to cover the remaining ones with either a "mail order" service or by local agents. On the subject of the latter, many controversial opinions have been expressed. It has been stated that a local agent, however good, can only serve as an introductory medium or even as a letter box, and that as soon as serious business is in the offing, headquarters staff, with an intimate knowledge of both the technical and commercial aspects of the problems as seen by the manufacturer, is necessary to conduct negotiations, however well they may have been introduced. Another school of thought contends that a well-chosen agent—after an appreciable schooling at the factory—can do all that is necessary until such time as business is sufficiently interesting to warrant the establishment of a Branch Office, Assembly Plant or Factory. But here problems of finance arise. Whereas profits in the past were such as to permit of considerable boldness, today there can be no question of a seller's market for aircraft, and the financial aspect of a sales organization becomes much more dominant. Thus, manufacturers are often faced with the difficulty of obtaining the right type of man, of

concentrating on a small well-trained sales staff, situated at headquarters but highly mobile, each member of which would have a stand-in capable of carrying on with the headquarters work emanating from his particular territory during his absence in the field. On many occasions this absence is prolonged, for it is no exaggeration to state that anything up to two years is the period of negotiation before sales contracts are ripe for signature.

Choosing the Customer

Another major problem now presents itself, namely, the "sorting out the wheat from the chaff." Every manufacturer of successful aircraft is likely to receive large numbers of "juicy"-looking enquiries which, unless he is careful, may result in considerable expenditure of time and money on preparation of route schedules, interior layouts, alternative power plants and the like. Hence, it is a *sine qua non* of good headquarters selling organization that a complete and up-to-date knowledge of all operators and potential operators be maintained. This will enable the manufacturer to give sufficient details to the "warm" prospect without undue expenditure of time and money, whilst giving the fullest possible information to a "hot" prospect.

Then comes the all-important question of financing. Many an operator or potential customer is found to be particularly lacking in frankness when it is a question of virtually disclosing his financial position to the aircraft manufacturer, however inevitable this may be. Thus it again becomes imperative that the manufacturer be as up-to-date as possible on the financial standing of his potential customers. When the moment arrives, he can—with as much tact as possible—conduct the financial discussions in a manner calculated to avoid loss of time and ensure the establishment of a basis of confidence. This must be followed by the imaginative brain of those responsible who produce, at the right moment and with the appropriate background, any schemes of financing which may be available, and which can be fitted into the potential earning value of the aircraft.

It is at this point that the aircraft salesman, if he is up to his job and can also produce schemes for better utilization, reduction of maintenance costs and other such alleviations, can often turn a "warm" prospect into a genuine potential sale, for hardly ever can it be said that there is such a thing as a straight sale of transport aircraft.

The aircraft salesman must always have before him the fact that his competitors never sleep, and if they do, they are probably occupying the next room to him in the same hotel without his knowing it, and are probably employing just as much brain and forethought on the same problem as he himself, though he is hardly ever able to see tangible proofs of this fact. He will, however, one day find himself flooded out by his own tears if he ignores this fact for one moment.

Studying the Customer's Needs

Long before there is ever any question of a contract it will be found necessary pretty well to share mistresses with his potential customer and study carefully all his planning whilst modifying his own program or specification wherever possible, before full confidence has been established not only in the aircraft itself but in the ability of the manufacturer to supply on time, and guarantee spares, repairs and replacements promptly and at all times during the life of the aircraft, wherever it may be.

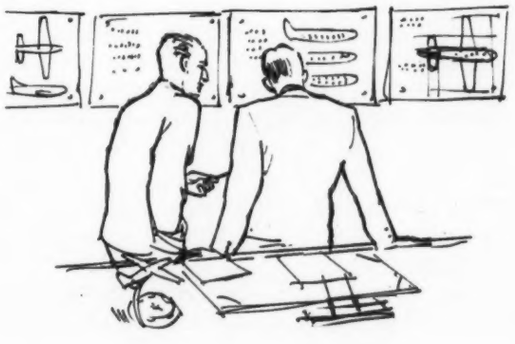
But as soon as some of these difficulties have been overcome, other problems will arise. There is the question, for example, of how far the manufacturer can go in meeting the wishes of the buyer, for in view of the present slim profit margins there is a limit to which he can go. Yet, no two operators in the world seem to be satisfied with the same interior layouts, cockpit planning or colour schemes. What may seem to be a small alteration in certain of these categories may well cost more than it is worth, and there is nothing more unsatisfactory than for a salesman to indicate to a prospect that the factory can make this or that change, only to have to come back later on and quote a charge which the customers may well regard as disproportionate for such modifications. What the prospect will not realize is that even minor alterations may involve many hours of work in the drawing office, the procurement of special materials which may delay the delivery dates, or even fresh certification by the Authorities and ensuing delays.

A salesman who incorporates all the qualities necessary personally to overcome every difficulty he is likely to encounter just does not exist. Hence, it is obvious that close and constant liaison with the factory and technical organization of the manufacturer is the only correct background to foolproof selling.

The Question of the Contract

When the stage of an actual sale is finally reached, the compilation and presentation of the sales contract presents the next question. This moment calls for a considerable amount of psychological understanding of the customer, who will probably state at the outset that he is not interested in the fact that a manufacturer has what he terms his "standard form of contract." Where, as is often the case, such documents do exist, it would be bad policy to refer to them as such, for even if they can be used the customer much prefers to feel that the contract has been drawn up especially for him. In fact, it is hardly ever possible to use more than a small portion of such standard contracts except for the stereotyped phrases. Long before this point is reached, however, the salesman must have thoroughly investigated the local leading aspects of a contract, the currency regulations which may govern it and what would be the deciding factors in the event of late deliveries, non-payment or the like. No matter how good the head office lawyers may be in drawing up a contract, it is the salesman's job in the field to advise head office on local conditions and laws governing such contracts in the territory in question. He must provide all the odd bits of information as to whether the language in which the contract is drawn up may even invalidate it, whether large taxes or stamp duties may be levied on the contract in the case of litigation, and what may be the necessary escape clause in the event of happenings which would fall under the heading of *force majeure* in the country of the manufacturer but be disregarded in the territory where the aircraft is sold.

If, therefore, the salesman, working in close unison with the appropriate departments at headquarters, can then finally conclude the sale, he may pat himself on the back with the full knowledge that if he can sell aircraft under those conditions he can pretty well sell anything.



Lockheed's public relations department keeps the *Constellation* picture and name in front of the public also through the editorial pages of the daily press.

CROSSES U.S. IN 7 HOURS
Giant Plane Goes 380 mph.
First-Hand Revelation Of "Cold-Plated Constellation"
Clipper Off on Round-the-World Trip
Connie, Ford To Cr
U.S. In Hour-Tests
Big Plane Today Starts Survey Atlantic Flight

How to Advertise a Transport Aircraft

Brand Demand and Aeroplanes

BY GENE GACH, LOS ANGELES

Advertising specialists know *brand demand* as that artificially activated impulse which cajoles buyers into specifying purchases by make and/or manufacturer. Creating it is a warily planned, highly scientific and sometimes Machiavellian operation. It adjures us to say *Bayer* instead of aspirin, *Coca Cola* instead of carbonated cola drink.

When the end of the war was in sight and peace presaged increased civilian air travel, aircraft manufacturers turned to their sales development programs with thoughts of *brand demand*. Could you get people buying airplane tickets to insist on travelling in specific types of transport aircraft ?

Two Juliets to one Romeo in this aerial romance posed a triangular quandary. Should the aircraft maker woo the purchasers of airplanes, the airlines ; or the purchasers of airline tickets, the passengers ? To the stricken suitor, whose langorous eye was on the multi-billion dollar airplane purchasing funds bulging the budgets of PAA, TWA, American Airlines, BOAC, Air France, KLM, Eastern Air Lines and other carriers with conspicuously fat postwar dowries, the choice of spending the advertising budget on the airline or its passengers was stark drama.

Tracing the advertising histories of all U.S.A. airframe manufacturers since war days would be interesting. But because it would be prohibitively lengthy, complicated, and eventually lead to comparisons, this examination is restricted to the advertising of one company, Lockheed. And to pinpoint the subject further, it is isolated to one airplane, the "Constellation."

Prior to the "Constellation's" debut as a commercial passenger transport, Lockheed had established an advertising theme still seen today, "Look to Lockheed for Leadership." Initiated over ten years ago when the Burbank, California, plant bought space to call attention to the merits of its Model 18 "Lodestar" and its military counterpart, the "Hudson" medium bomber, "Look to Lockheed for Leadership" has since been heralded in relation to the P-38, the "Ventura," the P2V, the "Constellation" and the "Constitution." This linking together of different aircraft made under the same roof, this creation of a family relationship through the use of one theme serves to make the man who is favourably impressed with one plane partial to its kin. It trades on origin. The USAF pilots who flew the P-38s, the English RAF who named the "Hudson "bomber "Old Boomerang" (because it always came back), the Navy fliers who circled the globe in the P2V "Truculent Turtle," must be subconsciously loyal to all Lockheed craft through loyalty to the one they knew intimately.

When Lockheed determined tactics for the "Constellation" advertising they struck out boldly in favor of wooing the passenger. A dollar spent in trying to sell "Constellations" to a specific airline would only help Lockheed, but the same dollar spent in selling "Constellations" to all air travellers benefits all lines flying that plane. Feeling that money allocated to addressing "Constellation" ads exclusively to the airlines was inconsistent with long range benefits, Lockheed went on record with their potential customers as avowedly setting out to make all air travellers all over the world "Constellation" travellers by choice. And in the last six years they spent several million dollars selling seats on "Constellations."

First Phase Introductory

Like all *first* ads in transportation, first "Constellation" ads had the job of telling *what* it was, *why* it should be preferred, and *where* it was available.

Lockheed saw this hurdle as an advantage. Having something new to advertise they advertised it as *news*. They sold a new kind of air travel. Lockheed, who at the time had a technological lead on their competitors, made the most of it, hammered away triumphantly at being able to offer three major exclusive advantages :

"GREATER SPEED !
GREATER COMFORT !
GREATER SAFETY !"

But theirs was no patented secret, and Lockheed engineers knew it. Competitors would eventually advertise planes with equal or greater speed, with pressurized cabins and with four engines. Meanwhile, however, they exploited every advantage of being the first postwar model with all three of these *greaters* in one plane and boasted these claims not only in USA magazines and twenty-two of the nations largest circulation daily newspapers, but also in European, South American, African and Scandinavian publications.

Started in January 1946 and running through September 1946 these ads had a number of elements in common. All of them

(1) repeated variances of the three then exclusive features, *greater speed, greater comfort, greater safety ;*

(2) hammered at the coined word *Normalair* in an attempt to contribute a new word to air travel that would minimize competitors' eventual offer of mere pressurization ;

(3) made friends with travel agents by suggesting that "Constellation" passengers consult travel agents for tickets, schedules ;

(4) made friends with airline customers by listing those who either flew or planned to fly "Constellations" ;

(5) repeated the slogan at the bottom of the ad, "Look to Lockheed for Leadership. Years ahead in the science of flight."

Aviation Enthusiasts Courted

During Lockheed's post-war romance with prospective passengers, another minor flirtation was under way. The company appreciated the word-of-mouth propaganda power of great numbers of new aviation enthusiasts, men and women who knew more than a smattering about ailerons and fuselage. Many of these were war-borne. Some had been pilots, gunners, navigators. Others, however, had never been off the ground. With these enthusiasts Lockheed carried on a clandestine courtship through a series of pseudo-technical advertisements entitled "HANGAR FLYING."

Engine cowlings obligingly yawned for bearded, stethescoped physicians ; dismayed hens regarded eggs with propellers ; a stunt man rode the top of a "Constellation" whacking out a window in flight ; and a quizzical whale cast questioning eyes skyward at an overhead airplane—these provided illustrations for HANGAR FLYING ads.

Semi-technical, easy to read, and yet spiced with a smattering of aviation jargon, HANGAR FLYING gave the sophisticated aviation enthusiast a conversational gambit. They enabled him to talk intelligently. But only regarding and in praise of one airplane. Today Lockheed officials remember the series as an important element in the campaign which helped establish the "Constellation" as a leader in the transport field.

Competition Catches Up

Lockheed could not boast of exclusive features forever. Came the day when other companies began to catch up, and offered planes with comparable speed, equal number of engines and safety features, and with pressurized cabins. And on that day the company was ready with a new campaign.

At the time when its competition was boasting of mechanical and scientific virtues, Lockheed, without minimizing the technological merits of the "Constellation," concentrated on glamorizing her.

"People will prefer to ride in the plane that is known to carry actresses, statesmen, leaders," Lockheed advertising officials predicted. And they launched a campaign aimed at making, "I flew in a 'Connie'" equivalent to saying, "I flew in the world's most glamorous plane. I rode in the company of wonderful people. I sat next to Clark Gable, in front of a Countess, and behind a multi-millionaire."

Edward Bosley wrote the copy for this series, the captions for which always began as "The Story of..." He must have had a wonderful time. All he had to do was ride "Constellations", meet interesting people and record their remarks for these ads. In executing this commission his whimsical, breathless reports included conversations with Sir Alexander Korda, a printer of legal currency, Carmen Miranda, seven barefoot members of the Honolulu track team, author Franklin P. Adams, an army nurse, countless inventors of odd equipment, actresses Olivia De Havilland, Nanette Fabray, Lizbeth Scott, Beryl Wallace, Janet Blair, Lucille Ball, Egyptian actress Tahia Korim, songwriter Hoagy Carmichael, diplomat Alan Hadden, African physician Marie Antoinette du Prey de la Ruffinière, movie producer Edward Small, and many others. Toward the end of 1946 Lockheed made one slight change in this series, changed its title from "The Story of..." to a standard "Lockheed Constellation Guest Book." Copy and illustrations were still treated in the same blithe, sprightly vein.

The Plane that goes Places

In 1947 Lockheed switched into Phase Two of their "Constellation"-glamorization advertising program. For a year it had been the plane for glamorous people. If you wanted to travel with glamorous people, fly the "Constellation". Now it entered into the "Ride-the-plane-that-goes-to-far-away-romantic-places" phase.

Dominated by full color imaginative illustrations, each of which showed a "Constellation" over a different foreign capitol, these, too, were linked by similarities :

1. They were all captioned, *Leader to such-and-such-a-city—Leader at home.*

2. There was scarcity of wordage, emphasis on full color design.

3. They all showed a "Constellation" over either a nation's capitol or its symbol.

Ad men will be interested to know that Lockheed sales development officials gave artists carte blanche to paint whatever subject best typified their individual assignments. Noel Quinn felt the Chariot of Boadicea against the Big Ben Tower symbolized London. Elmer Plummer's stylized windmill identified Holland. And John Moximus wrapped up Paris with a flower girl near the Arch of Triumph.

The written words were not without their artistry, flights of poetry, as evidenced by the following example :

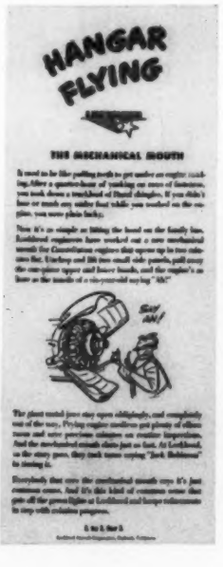
"Swiftly your 'Constellation' rides to the East, swiftly above the Atlantic arc and sun path, cleaving the meridians, racing the westerlies, raising the cliffs and greens and majesty of England."

The combination of the two campaigns, selling the plane that goes to far-off, romantic places, in addition to the plane that carries distinguished passengers, was designed to

The introductory "Reason Why" campaign started in January 1946. It placed its emphasis on "Greater Speed, Greater Comfort, Greater Safety." Ad at left pointed to safety margin provided by 4000 surplus horsepower.

The "Hangar Flying" series courted aviation enthusiasts. Pseudo- or semi-technical ads described novel features of the *Constellation*.

When the competition began to extol the mechanical and scientific virtues of their own products, Lockheeds set out to "glamorize" the *Constellation* as the airliner used by distinguished, glamorous people. Captions for this series always began as "The Story of..." Pictured in the ad at right is Lizbeth Scott, who weighs 115 lbs...



"Leader Abroad, Leader at Home" : The airliner that goes to far-off, interesting places... London, Rome, New York, Rio de Janeiro, Holland, Paris, Mexico ...

create an emotional partiality to the "Constellation" that would prompt passengers to specify the plane by name over and above the attractions offered by any other plane. People who wanted to say, "I came by 'Constellation'" because they felt that by so saying they surrounded themselves in an aura of glamour, in the personality of the "Constellation's" distinguished guests, in the color of the far-off, distant places on the "Constellation's" itinerary, probably were deaf to the advertising of other planes whose claims inferred engineering superiorities.

Other Forms of Advertising

The campaign did not end with the-plane-that-flies-to-romantic-places series. The current campaign is establishing the "Constellation" as the "intercontinental leader," and repeats that "...the Constellation carries three times as many passengers, month in and month out, as all other transports combined. It has been tried and proven by 4,000 million passenger miles of dependable service on every continent of the world."

This theme has dominated the current series of "intercontinental leader" ads since late 1948. But Lockheed's advertising has not been restricted to newspapers and magazines. Themes corresponding to their current newspaper and magazine campaigns have been seen in full color on *highway billboards* adjacent to principle airports all over the USA and Europe.

Furthermore, early in "Constellation" seat selling campaigns the *travel agent* was conceded to be a key figure. He was given counter cards, calendars, ash trays, model airplanes, window displays, blotters, folders, sales literature, lapel pins, anything and everything that would familiarize him with the "Constellation," make him a Lockheed booster.

At one time the travel agent was inundated. Lockheed was giving him material for his counter. Lockheed was giving their airline customers similar sales aids. And the airlines began competing with Lockheed for "Constellation" space in the travel agent's windows, on his desk. To eliminate this needless civil war Lockheed's advertising staff established liaison with airlines flying "Constellations" and offered travel agents better and more compact point of purchase material under controlled conditions.

While Lockheed's advertising department were buying space in newspapers and magazines, their news bureaus were arranging for *publicity stories*. Lockheed press agents in

principal cities saw to it that distinguished travellers were reported as "coming by 'Constellation,'" "Connied in..." and "via 'Constellation'" rather than just "by air." The "Constellation" appeared repeatedly in word and illustration in newspapers, magazines, comic strips, motion pictures, radio programs. Moreover, every time the "Constellation" made a new run it created a new speed record, and the newspaper men were always on hand with headlines.

Built-in-Payload

Lockheed has a term for the over-all impression they claim to have evoked by their newspaper, magazine and billboard advertising, their publicity campaigns plus the fact that theirs is a basically fine airplane. This term is "built-in-payload," and Lockheed sales personnel translate it to prospective plane purchasers as equivalent to the assurance that with each "Constellation" is delivered an invisible but powerful impression in the minds of air travellers that the "Constellation" is a superior airplane.

In evaluating this claim it must be conceded that people use certain soaps because they want to be glamorous, eat a certain breakfast food because it is the breakfast of champions, smoke a certain cigarette because "doctors have found it less irritating to the throat." These are all advertising indoctrinated drives. Accepting them as valid, and using them as a basis of comparison with Lockheed's recent multi-million dollar advertising and publicity campaign to imbue the word "Constellation" with the aura of (1) speed, comfort and safety ; (2) glamour and distinction ; and (3) leadership, one begins to discern an element of "Constellation" selling invisible to the uninitiated. And "built-in-payload" is as good a term as any.

The current "Tried and Proven" campaign sets to establish the *Constellation* as the "intercontinental" leader carrying more passengers on trunk lines than any other type.

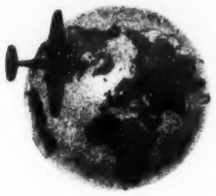
Billboards of huge dimensions "decorate" U.S. highways, buildings in towns and suburbs, near airports...

Handle with care—Piano!

It is not quite correct to describe the carriage of freight as a "novel" branch of air transportation. It is as old as civil aviation itself. As long ago as 1919 an intrepid passenger could, if he was bold enough, ride from Paris to Bucharest in an open caudron C. 23 mail aeroplane, but he had to content himself with being accommodated on and between crates of live lobsters that were being flown to the swank eating places of the Rumanian capital. Air transportation has come a long way since 1919, and our picture shows it. Today you have air freight exchanges in London, Paris, New York and elsewhere, removal contractors specializing in shipment of furniture by aircraft, national associations of cargo transport operators with forty or fifty member companies. A modest piano therefore nearly escapes one's attention.

The carriage of this piano by air is significant nevertheless, because this commodity is neither perishable nor, calculated per pound of weight, of very great value. The picture is of importance just because such transports no longer represent isolated events. A two-ton truck of "Nordisk Transport & Spedition A. B.," Stockholm forwarding agents, has driven out to the airport to take delivery of a piano flown from Paris to Malmö in a chartered Douglas DC-3 freighter. It is merely one of countless shipments which are loaded and unloaded day by day at Bulltofta Airport, Malmö, the center of Sweden's air freight business. In the second half of 1949 alone "Nordisk Transport" chartered Douglas DC-3 aircraft from "Société Transatlantique Aérienne," French non-scheduled carrier, for a total of forty flights. For hundreds of forwarding agents in all countries of Europe the cargo aircraft has become as commonplace and indispensable as a furniture truck, a railroad car, canal and river barges. Swedish calculating machines, ball bearings, machine tool spare parts, dopes and varnishes and culinary specialities wing their way from Sweden to the Continent. At Le Bourget Airport, Paris, the subsidiary of "Nordisk Transport" loads nylon hose, fresh fruit, cut flowers, fashion models (the kind one sends in cardboard boxes, of course) and other goods on aircraft flying back to Sweden.

"Handle with care—Piano !" at an airport no longer indicates an unusual item of air cargo or an extraordinary performance. Like in any other cargo shed in the world it simply means, "Don't tip the thing over, it's fragile !"



What's in the Air?*

INTERNATIONAL AVIATION POLITICS of the last few months were dominated by three major issues : (1) American arms aid to Europe, (2) Expansion of the Western civil aviation field through the conclusion of bi-lateral air transport agreements, and (3) Review of air transport nationalization tendencies in the British Commonwealth.

(1) Portugal and Iceland are the only European signatories of the Atlantic Pact who so far have not requested any share in the *arms supplies to be furnished by the U.S.A.* (other members : U.S.A., Canada, Norway, Denmark, Britain, France, Belgium, Netherlands, Luxemburg, Italy). Of the American defense budget project for the 1950-51 fiscal year ($13,545,000,000), submitted to Congress by President Truman on January 9th, the sum of $1,148,000,000 is earmarked to finance this military assistance. The beginning of actual deliveries was delayed in the case of Britain by delicate negotiations in which the British Government sought to clarify the modalities of the new military assistance agreement. The U.S. administration is now doing everything in its power to expedite the shipments. On February 2nd it published a list of military advisers who are being sent to the capitals of seven participants in the arms scheme (London, Copenhagen, Brussels, The Hague, Rome, Oslo, Paris) to help the military authorities of those countries with transport and training problems. In London Major General Leon V. Johnson, Commanding General of the Third Air Division in England, additionally became chief arms adviser. The R. A. F. will receive 70 Boeing B-29 "Superfortress" long-range bombers, and combined with the 90 heavy bombers of the Third Air Division, this force will constitute an important factor in the air-strategical potential of Western Europe. — In his annual report, published on January 30th, U.S. Defense Secretary, Louis A. Johnson does not forsee "immediate and spectacular results" from the North Atlantic military assistance programme, but he states that the armed forces of Western Europe, operating under integrated plans, would be able to hold the lines of collective defense of the North Atlantic area during the time which would be required for the United States to establish and transport its own troops across the Atlantic Ocean.

(2) The member nations of the British Commonwealth and countries close to them continued to organize their commercial air transport interests in the Near and Middle East. This is shown by their vast activity in the field of *civil aviation negotiation* and the ensuing conclusion of several air transport agreements, such as Ceylon-Egypt and Greece-Egypt, whereas others are on the point of being signed—Britain-Egypt, South Africa-Egypt, Australia-Egypt, Netherlands-Syria, South Africa-Israel, Italy-Libya.

Beech 50 "Twin Bonanza."

More spectacular than this diplomatic routine work was the signature of the *U.S.-Yugoslav air transport pact,* followed by parallel Italo-Yugoslav and Franco-Yugoslav negotiations. No matter how one assesses the ultimate intentions of Yugoslavia's political leaders, the air-political break between that country and the Eastern bloc is an accomplished fact. Yugoslavia has imposed prohibitive flying and landing restrictions for all Russian, Polish, Hungarian, Rumanian and Albanian aircraft, so that only the Czech C.S.A. airline is now able to maintain a limited (twice weekly) service to Belgrade.

*

The formation of a Right-wing government in Australia (the new Minister for Air and Civil aviation is a World War I pilot, T. W. White) has had an important effect of the *situation of the major private Australian airline operator,* Australian National Airways (A.N.A.). A spokesman for the Australian Government declared that while Trans-Australia Airways, the Government's domestic airline, and Qantas Empire Airways, Government-owned international operator, will continue in existence, they will receive no preferential treatment in the future. A first illustration of this change seems to be A.N.A.'s authorization to inaugurate an air service between Melbourne and Christchurch, New Zealand, which will be flown three times a week with Douglas DC-4 aircraft.

In India, Prime Minister, Pandit Nehru announced that the nationalization of the country's airlines was neither feasible nor practicable, and in England the Conservatives, prior to their narrow defeat in the General Elections, promised a revision of the present status of the nationalized airline corporations.

The *AIRLINE INDUSTRY* of the United States had a pleasant surprise when it was told that President Truman's budget plan provided for record appropriations for civil aviation. It was also quite pleased to hear from Secretary of the Treasury John W. Snyder that the passenger transport tax is to be reduced from 15 percent to 10 percent, while the 3 percent cargo transport tax will be dropped altogether. Several other minor sensations were not lacking, such as the attempt by Major-General Claire L. Chennault, President of the Civil Air Transport, an airline formerly operating in China, to buy up the capitalization of China National Airways Corporation and the Nationalist Government's Central Air Transport Corp. and thus to acquire the air fleets of the two lines, a major portion of which at present is stationed at Hong Kong airport. The attempt ended provisionally with a ruling by Hong Kong's courts to the effect that neither of the opponents had a legal right to the aircraft in question (the General's opponents were the Chinese Communist Government).

More interesting than these events was the news that a Civil Aeronautics Board Examiner had recommended the *sale of American Overseas Airlines to Pan American World Airways* for $17,450,000. As was to be expected, this recommendation provoked a flood of protests and counterprotests. Transcontinental & Western Air (T.W.A.) commented with a certain amount of bitterness that the C.A.B.'s Examiner was the same official who after the late war wanted to prevent T.W.A. from inaugurating its Atlantic services. The U.S. Department of Justice also intervened, describing the Examiner as "biased and prejudiced" in favour of P.A.A. Subsequently this charge was dropped or at least toned-down, but the Judiciary Committee of the House of Representatives nevertheless decided to hold an investigation into alleged monopolistic practices in certain industries. The Chairman of the Committee, Celler, stated that the inquiry would pay attention to Pan American Airways in particular.

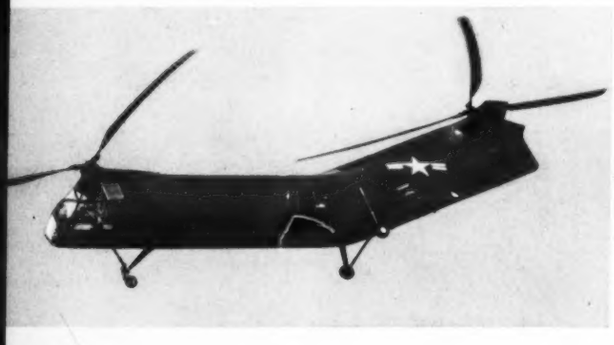
De Havilland "Heron."

In the meantime, T.W.A. received some measure of consolation for its pains. It will be able to carry out pilgrim flights to Rome during this Holy Year without fear of direct competition by P.A.A. On January 24th the C.A.B. rejected P.A.A.'s application for authority to operate low-fare charter flights to Rome on behalf of a Roman Catholic organization called "Felix Roma."

However, T.W.A.'s "pilgrim monopoly" is not absolute. In the world's airline pattern of the spring

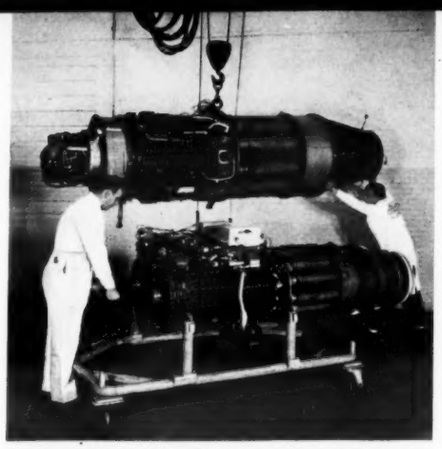
* Based on reports published in "INTERAVIA AIR LETTER," daily international aviation news digest appearing in English and French.

Piasecki HRP-2.

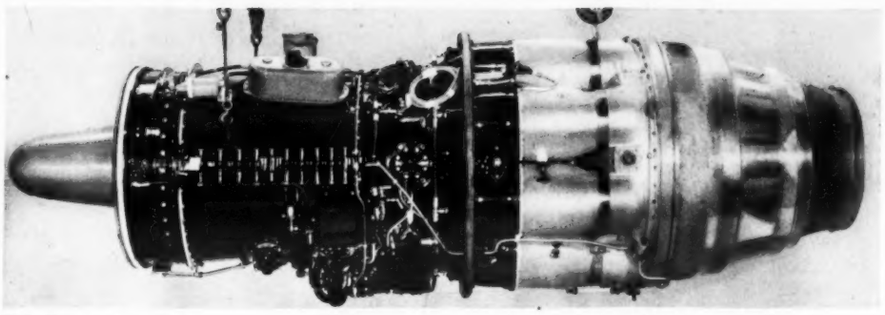


Bell XH-12.

McDonnell XHJH-1 "Whirlaway."



Bottom : 5600 h.p. Allison T-40 twin-gas turbine without shafts and transmission. Above it an Allison J-35 gas turbine unit of 3,800 lbs. static thrust.



Rolls-Royce "Avon" jet.

of 1950 it seems that "all roads lead to Rome". In May the Italian LAI will inaugurate its New York-Rome service with Douglas DC-6 aircraft. Air France is increasing the frequency on its Paris-Rome route, K.L.M., F.A.M.A., B.E.A.C., and IBERIA are also intensifying their Rome schedules.

Indications of a closer collaboration in Europe's air transportation have recently become apparent. At the end of last year representatives of the ten largest European air lines, A.B.A., Aer Lingus, Air France, B.E.A.C., D.D.L., D.N.L., K.L.M., Sabena, S.A.S. and Swissair, met in Brussels to discuss measures to rationalize the purchase of equipment and spare parts in the United States. Standing committees were appointed to work out the details. On January 18th a second conference was held in London, this time attended also by B.O.A.C.

On the whole, it seems that world air transportation may have confidence in the year 1950. Sir William P. Hildred, Director General of I.A.T.A., announced that in 1949 the I.A.T.A.'s member airlines carried more than 25 million passengers, that an airliner took off or landed every five seconds by day and night and that more than 10,000 passengers travelled daily by air in Europe alone.

The list of *NEW AIRCRAFT TYPES* which made their initial flights around the turn of the year is short in comparison with the impressive record of the 1949 summer months. Apart from variants of existing models, it comprised the following prototypes :

Beech "Twin Bonanza" twin-engined touring aircraft (U.S.A., November 15th, 1949) ;

Sikorsky H-19A military helicopter (U.S.A., November 21st) ;

Douglas C-124A "Globemaster II" giant military transport (U.S.A., November 27th) ;

Nord 2200 jet fighter (France, December 17th) ;

Avro CF-100 twin-jet fighter (Canada, January 19th, 1950) ;

Nord 1601 twin-jet experimental type (France, January 24th) ;

North American XF-93 jet fighter (U.S.A., January 25th).

However haphazard this list may be compiled, it nevertheless provides a few clues to present development trends in the aircraft industry :

The Beech "Twin Bonanza" twin-engined five- to six-seater development of the well-known "Bonanza" single-engine four-seater shows that American personal aircraft manufacturers are turning from the production of small private aircraft to the manufacture of larger executive type transports. Recent sales statistics are the most pertinent reason for the changeover : In the year 1948 they sold 3,565 four-seater and 3,404 two-seater private aircraft ; in 1949 these figures dropped to 2,328 and 1,030, respectively, representing a 70-percent reduction in the case of two-seater light planes and a drop of "only" 35-percent in that of four-seaters. Why should it not be worth while to develop larger and, chief of all, better-performing personal aircraft ? It seems that this category of aeroplane increases in importance with the progressive withdrawal of air transportation from small fields and small towns as a result of the gradual disappearance of the Douglas DC-3.

In Britain the problem of the *feeder airliner* was even more conspicuous. So far it has been solved by the use of the De Havilland "Dragon Rapide" biplane which was able to operate from and to fields inadequate even for the Douglas DC-3. But the „Dragon Rapide" has not only reached the age limit but also is too small. A design competition organized by British European Airways for a four-engined (!) replacement brought 20 tenders, but at the request of the Ministry of Civil Aviation the Company decided not to order a costly new model and to content itself with the somewhat oversized Handley-Page (Miles) "Marathon," which has the advantage of having been in flight for some time. As a private venture the De Havilland Aircraft Co. has meanwhile built a four-engined model roughly meeting B.E.A.C.'s requirements : the "Heron." It is derived from the twin-engined "Dove" (375 h.p. D.H. "Gipsy Queen 71" engines) and accommodates 14 to 17 passengers. The new model has 250 h.p. "Gipsy Queen 30" direct-drive engines, fixed landing gear and, even with one engine inoperative, a shorter take-off run. These characteristics make it a very unpretentious type so far as maintenance and field requirements are concerned.

Another solution of the feeder line problem lies in the *helicopter*. In the last few months four American helicopter manufacturers have bid for a U.S. Air Force contract for a series of large Arctic rescue helicopters : the Piasecki Helicopter Corp. with the improved HRP-2 version of its "Sagging Sausage" (officially the HRP-1 "Rescuer") ; the Bell Aircraft Corp. with its XH-12, hitherto known as a five-seater ; Sikorsky with the H-19A, mentioned under "Progress in Pictures" of this issue ; and McDonnell Aircraft Corp., with the twin-engined XHJH-1 "Whirlaway." Since the design competition specified a rescue helicopter with a crew of two and a cabin for eight occupants, it was relatively easy for the bidders to evolve civil transport versions from their basic types without incurring excessive development costs : Piasecki has announced three versions, the 21-passenger "Commuter," the fifteen-passenger "Connector," and the eleven-passenger "De Luxe" type ; Bell offers its twelve-seater "Feeder-Liner" and Sikorsky its ten-seater S-55. In the meantime, the Air Force has decided in favour of a development of the Piasecki HRP-2, designated the H-21. The second, civilian round of the competition has now started with efforts to provide the equipment for the first regular passenger helicopter feeder services which are to be organized in the New York area.

The third clue refers to large transport aircraft for military and commercial purposes, particularly to types powered with *propeller turbines*. In the near future the British lead in this field will no longer be undisputed, for in the middle of February the head of the Allison Engineering Division of General Motors, E.B. Newill, and LaMotte T. Cohu, President of Consolidated Vultee Aircraft, announced flight tests of the "Convair-Turboliner" for the comming summer. The machine is a conventional "Convair-Liner" powered with two Allison T-38 propeller turbines rated at about 2,800 h.p. Quantity production could start within a "relatively short time." Little is known of the Allison T-38 turbine, since it was originally developed for the U.S. Navy ; however, it is reported to have brilliantly passed a series of rigorous bench and flight tests. For greater power Allison has created a power plant designated Allison T-40, which consists of two T-38 engines working on a common gear ; if necessary, long extension shafts can be used. Four such units have been mounted in the Convair XP5Y-1 flying-boat, which should have started its flying trials by the time these lines appear. Another aircraft type which might benefit by this engine is, according to the U.S. trade press, the Douglas "Globemaster II." The single T-38 turbine is recommended by the Allison Division also for installation in the Boeing "Stratocruiser," the Douglas DC-6 and the twin-engined Martin 2-0-2 ; the last named, incidentally, is now being built in a new version called Martin 4-0-4 and featuring a pressure cabin and longer fuselage.

From the propeller turbine to the *pure-jet commercial transport* the mental step is relatively small. The De Havilland Aircraft Co. Ltd., continues to keep the trade world on tip toes by issuing carefully measured data, based on test results, on the "Comet" jet airliner. The much-discussed question of whether the range of the "Comet" would be sufficient to permit operation on the Atlantic (as is known, the aircraft is designed for the Empire Route to Australia and not for North Atlantic operations) is given half an answer : in its present state of development the "Comet" could carry a payload of 8,750 lbs. on the Prestwick-Gander crossing (2,116 miles) with a 50-percent regularity, or 5,800 lbs. with an 80-percent operating regularity.

The Americans too, have at last decided to pay serious attention to the development of pure-jet passenger liners. It appears that very few manufacturers are capable to bear unaided the high-costs of designing, building and testing a jet-propelled prototype for which the commercial airlines have shown little appetite so far. At the same time, none of them desires to risk losing the potentially lucrative future jet transport market. Governmental subsidies ? Divergent interests of the individual manufacturers so far have made a concerted stand by the entire U.S. aircraft industry impossible. The Aircraft Industries Association, the representative body of U.S. aircraft makers, has now decided to give full backing to a "Transport Prototype Bill" which would authorize the U.S. Government to finance the development of new transport aircraft types in the interests of national defence. — A similar stage has been reached by the same problem in France, where the nationalized S.N.C.A. du Sud-Ouest has produced a pamphlet to convince Parliament and public of the necessity to appropriate the money for the immediate construction of a jet transport type designated SO 5100 "Champagne." The machine would have four Rolls-Royce-Hispano "Nene" engines.

Avro-Canada XF-100.

The initial flights of *French prototypes* just listed, to which should be added those of the first "Vampire" fighter built in France ; the first production model of the Bréguet 761 four-engined freighter and two versions of the SO 6020 heavy fighter, are symptons of a considerable revival of activity in the French aircraft industry. To complete the record, mention must be made of the maiden flight of the *first Canadian jet fighter*, the Avro-Canada XF-100. This all-weather two-seater is powered with two Rolls-Royce "Avon" gas turbines and is claimed to be the world's most powerful fighter.

The British Aircraft Industry (VII)

BY C. G. GREY, LONDON

Sir Frederick Handley Page and his Company

Sir Frederick Handley Page, who was created a Knight in 1942 for his services to British aviation, is the only one of the pioneers who, after forty years, is still the active head of the aircraft firm which bears his name. Not only is he the head of the firm, but he is still the leader, the inspiration, the governor, the director, the motive power of the whole concern.

Handley Page Ltd. was registered on June 17th, 1909, without any frills about Aviation or Aircraft, but its "Articles of Association" said that its objects were "to carry on the business of manufacturers, letters to hire, and repairers of and dealers in aeroplanes, hydroplanes, airships, balloons, aeronautical apparatus and machines, automobiles, motorcars, etc." So Handley Page Ltd., still under the same name today, could do almost anything—and did.

Frederick Handley Page not only is one of the great characters of British aviation, but he has influenced the whole history of aviation in a number of different ways. Apart from which he has been a continual joy to me for 40 years. I do not know anybody from whom I have derived so much entertainment, mental, educational and physical. Just to watch his career has been an entertainment in itself.

So far as my memory goes, the first time I met him was in a wooden shack built on that piece of wasteland down Barking Way which was made by dumping the earth, clay, rocks and anything else which was bored out in the process of making the London Tube Railways along the South bank of the Thames east of Barking. I believe the Ford factory is built on some of it.

Somewhat naturally, 40 years ago this artificial wilderness had no great surface value. Young Mr. Handley Page at that time was willing to make any aeroplanes for anybody at a price. I have always thought that one of his great achievements was to get an order to build an aeroplane for Signor Caproni, who in later years became known to the world as Count Gianni Caproni, one of the leading makers of aircraft.

At or about that time, partly to spread the gospel of aviation and partly to add to his necessarily small income as an aircraft manufacturer, H.P., as we soon learned to call him, was a lecturer on aeronautics at the Northampton Institute, somewhere in the City of London, which, I may say, has benefited very much from its connection with him since then.

One has curious little snapshots which stick in one's mind of those early days. I suppose somewhere about 1910 or 1911 when the Barking factory was still in existence, one of the Petre brothers of Brooklands joined H.P. He was always known as "Peter the Painter," after a popular murderer of the period. He was one of the most charming men I have ever met, and when he was killed not long before the war in 1914 at Marsk in Yorkshire (not on an H.P. machine) he was sincerely mourned. But the Painter had a way of his own and I still well remember him in that shack bringing along to H.P.'s office a Norwegian who had come over here to learn something about aeroplanes — Heaven knows what. The Norwegian could not speak English and the Painter could not speak Norwegian, nor could H.P., for that matter, and Peter introduced him to the office with the memorable words : "I can't do any trade with this merchant." Meaning that he simply could not communicate with him.

Afterwards when the H.P. undertaking moved to Fairlop a bit more inland, but well in the fog-belt, it produced a monoplane which was

Sir Frederick Handley Page. "To watch his career has been an entertainment..."

Major R.E. Nicoll, Sales Manager.

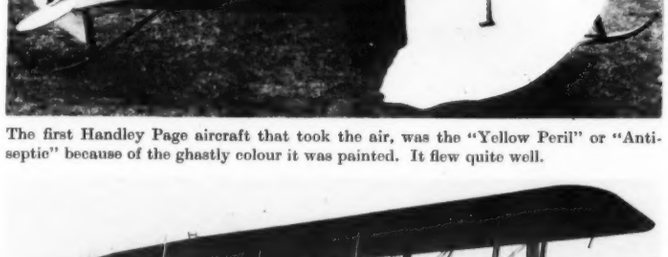
R.S. Stafford, Chief Designer.

W.H. Macrostie, Chief Designer.

Dr. D. Lachmann. — As an "enemy alien," he designed an aircraft for H.P.

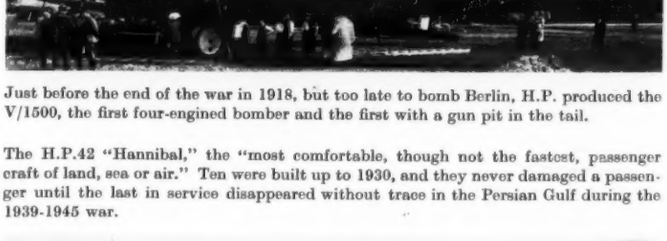
J. Hamilton, Works Manager.

The first Handley Page aircraft that took the air, was the "Yellow Peril" or "Antiseptic" because of the ghastly colour it was painted. It flew quite well.



Just before the end of the war in 1918, but too late to bomb Berlin, H.P. produced the V/1500, the first four-engined bomber and the first with a gun pit in the tail.

The H.P.42 "Hannibal," the "most comfortable, though not the fastest, passenger craft of land, sea or air." Ten were built up to 1930, and they never damaged a passenger until the last in service disappeared without trace in the Persian Gulf during the 1939-1945 war.



vaguely like an Etrich or a Rumpler, with swept-back wings and upswept tips, and some pretence to inherent stability. I do not think the first one flew, but the second one, which was alternately called the "Yellow Peril" or the "Antiseptic" because of the ghastly colour which it was painted, did fly quite decently.

H.P. had been very properly brought up and before he (shall I say) descended to the aircraft trade had acquired that intricate knowledge of the Scriptures which has made him famous for his quotations alone. Few men can produce more apposite quotations on any and every occasion.

From Fairlop H.P. moved to a workshop at Cricklewood where, as soon as war broke out in 1914, he started building B.E. 2c biplanes in quantities. There the original little factory expanded handsomely.

The next stage was when he produced to Commodore Sueter, R.N., at the Air Department of the Admiralty the design for a big twin-engined bomber. That was when Admiral Sir Murray Sueter, as he now is, made up his mind on sight that here was a man who knew what he was talking about and was prepared to produce what he said he would. And he did.

Those twin-engine bombers were wonderful aeroplanes for their day. They made history and altered the theory of air war when based in the Dunkirk area between 1915 and 1918 and when a squadron of them was moved to Eastern France as part of General Trenchard's Independent Air Force. Also, after the war they pioneered civil aviation and made the first scheduled flights to India. Just before the end of the war in 1918, but too late to bomb Berlin, H.P. Ltd. produced the V/1500, a huge biplane with four Rolls Royce Eagle engines. Later still Cricklewood produced the H.P.42, or *Hannibal,* with four Bristol Jupiter engines, which I hold to this day was the most comfortable vehicle in which human beings have ever travelled.

During that period the Cricklewood Works produced a series of bombers in surprising varieties ; biplanes, and a strange machine which looked like a biplane upside down, and monoplanes. In 1939 they had already produced the *Hampden,* which at the beginning of the war did very good work despite the fact that the losses in *Hampden* squadrons were heavy because at the start they were not properly armed. That was the fault of the Armament Committee at the Air Ministry. The re-arming of the Hampdens by Air Vice-Marshal Arthur (commonly called "Bart") Harris on his own responsibility, without Air Ministry approval, is a story by itself.

While these developments were going on at Cricklewood, H.P. produced the famous "Handley Page slot." I suppose everybody concerned with aviation knows what that is. A slat of aerofoil section is carried along the leading edge of the wing, and so mounted that when the wing is tilted upwards, by tilting the machine, of course, at such an angle that normally it would stall and drop, the slat is pulled forward by the suction of the air, thus making a slot between the slat and the wing proper. Through this slot the air is led down over the upper surface of the wing, so that it continuously lifts, and if tilted still further it merely drops, it does not stall and dive.

I am particularly interested in the slot because I had the satisfaction of introducing it to the world at large in *The Aeroplane* in March 1920, at which time it was lucidly described in a technical article by W.H. Sayers who was then my technical man.

As happens with most great discoveries or inventions, people just would not believe it. We kept on talking about it until other technical papers had to take it up and finally it was accepted for what it is, a real life-saver.

Between wars it was widely used by our Air Force and in others. And here H.P. was very shrewd. Instead of granting licences to other companies and other makers to use the slot, he sold the use of it for a lump sum. It had acquired such a reputation in the newspapers that he got quite good sums for it, which certainly amounted to considerably more than he would have got on a royalty basis before the patent expired. All of which added quite considerably to the wealth of H.P. Ltd., and the dividends of its shareholders.

Fast and manoeuvrable, the H.P. "Hampden" was the R.A.F.'s standard bomber at the outbreak of war in 1939. Its disadvantage lay in its insufficient defence against fighters.

An example of the "Handley Page slot." The company made much money by selling the "slot rights" for a lump sum to other makers. This aircraft was the "Hendon" and had slots all along the wing.

The H.P. "Manx" tailless experimental monoplane, designed during World War II by Dr. Lachmann as the result of much research work. Lachmann was interned as an "enemy alien" at the time.

In connection with the slot there is a very amusing parallel. In Germany the Herr Doctor Lachmann, a war pilot of 1914-18, and one of the most charming men I know, also discovered this curious effect of the slot on his own account and had tried to patent it. The German Patent Office refused at that time to patent anything unless it could prove that it worked. But Lachmann could not build an aeroplane, as it was forbidden by the Armistice terms, and later by the Treaty of Versailles.

H.P. came to know of this patent application and saw that, although the idea was not patented in Germany, the fact that it was made known could be pleaded as an example of "prior-user," and might invalidate his own patent. So instead of starting a law action in Germany against the patent application he simply bought Lachmann and his invention. Lachmann has been here ever since. He was made a British subject in 1949 after having been interned during the war. And an interesting point is that during the War he studied and made working drawings for H.P. whilst interned as an enemy alien. The result was an interesting tail-less monoplane.

A point of interest is that although we all talk about the H.P. slot, H.P. himself has never claimed to be its inventor. He told me definitely

The H.P. "Halifax," one of the greatest war machines. It was fast, able to lift big loads of bombs and self-defending in all directions.

The "Hermes V" commercial transport prototype. Powered with four Bristol "Theseus" propeller turbines, it is a development of the piston-engined "Hermes IV," 25 of which are on order for B.O.A.C.

that it was not invented by anybody but just developed by various members of his technical staff working in their own wind-tunnel.

One of the problems which turned up very soon after the Armistice in 1918 was what was to be done with the tens of thousands of aeroplanes and the millions of pounds worth of aircraft material which belonged to the newly formed Air Ministry. Obviously if they were just thrown on the market as scrap, the country would lose millions of pounds.

Even as things were we lost a good few millions before anything was done with the scrap. All the aircraft manufacturers still had contracts in hand, practically to an unlimited extent, to turn out all the war material they could produce as quickly as possible. The aircraft and engine firms had contracts with the fitting firms and the raw material firms and naturally production could not be shut off with a switch.

Consequently the firms all went on making the stuff and there was nothing to be done with it. I know that many aircraft firms built hundreds of machines which were simply rolled out from the factory, smashed to pieces and burnt. The Government went on paying for them and the firms went on paying that money out to their workpeople and shareholders—when in fact it was all material and man-hours thrown away.

So Handley Page personally and Mr. Godfrey Isaac, a brother of Sir Rufus Isaac, later Lord Reading and Viceroy of India, formed a firm called the Aircraft Disposals Co. Ltd. to acquire all the aircraft and material which were owned by the Air Ministry. They agreed to pay the Government a million pounds, and half of whatever profit they might make year by year till they wound up the undertaking. I believe I am right in saying that at the finish instead of getting practically nothing at all for the stuff, the Government did in fact get 6 (six) million pounds.

The Disposals Co. took over an enormous factory which had been built at the corner of Purley Way and the road from Croydon to Sutton, at Waddon. It was to have been a great Government aircraft assembly factory if the war had gone on. The Aircraft Disposal Co., commonly known as A.D.C., filled the place with material. I remember going round one shed which was full of nothing but engines. My guide was young Major F.B. Halford, who had already distinguished himself by designing the B.H.P. (Beardmore-Halford-Pullinger) engine which later became the Siddeley *Puma*. He joined the A.D.C. as their chief engine man. He told me that the engines in that shed had originally cost the Government 6 million pounds.

There were all sorts, from the old early Renaults and Gnome up to the latest Hispano-Suizas and Rolls-Royce *Eagles*. Also there were a lot of engines bought from the U.S.A. which never ran and never could run, because somebody in the design department had made the water-jacket castings so that water could not circulate. Frank Halford will remember that.

One of the A.D.C.'s most successful lines of business was bringing in practically unused machines from R.A.F. stations, and machines which never had been flown from the factories where they originally built and bought by the R.A.F., and fettling them up till they were as good or better than new, and selling them to various foreign nations which aspired to have an Air Force as the result of the astonishing work done by the R.N.A.S. and R.F.C. and R.A.F. during the 1914-18 war.

The A.D.C. had a very able sales and technical staff headed by Lieut.-Col. Ormonde Darby, who had been one of the chief men in the Technical Department of the Air Ministry. They had able representatives all over the world wherever there was a nation to whom anything could be sold, and they sold these fettled-up machines against the products of the French and Italian trades.

You must remember that in the 1914-18 war we had 22 Allies, and up to the end of the war the U.S. aircraft trade, which was quite a big affair, had been building aeroplanes to British designs, mostly de Havilland and Bristols. Not one aeroplane designed in the U.S.A. ever crossed the fighting lines in France. The French had quite good designs, but they were not quite up to ours, and the Italians were more notable for their beautiful workmanship than for their designs.

Besides the design and construction of the British machines and their achievements during the war, which of course made splendid selling points, we had one immense advantage. That was the fact that every little bit and piece of every engine and aeroplane bore the stamp of the Aeronautical Inspection Department. And the A.I.D. stamp had acquired the same sort of prestige that the British Hallmark has on gold or silver.

The French and Italians actually tried giving their machines away a dozen or twenty at a time to such countries as the Argentine or Brazil or Peru, on the understanding that they tried them out thoroughly and would buy some if they found them satisfactory. The A.D.C. never gave away a thing. You could trust H.P. for that. But they gave splendid value. And foreigners very soon found that out.

But the A.D.C. was up against the solid opposition of the British aircraft industry as a whole—with the exception of Handley Page Ltd. Somewhat naturally the trade asked how on earth they could be expected to sell newly-designed and newly-built aeroplanes for thousands of pounds each when the A.D.C. were selling quite usable aeroplanes for hundreds or very few thousands. The position was difficult. But in the end everybody agreed that the A.D.C. were doing wonderful missionary work. Without the A.D.C. the British aircraft trade would have been trying to sell high-price aeroplanes against the very low-priced aeroplanes of the French and Italians. Also by this time the U.S.A. trade were beginning to come on the market. But the A.D.C. could undersell any of our foreign competitors.

I do not think there is any need here to go into the further story of Sir Frederick Handley Page—C.B.E., F.R.Ae.S., past President of the Royal Aeronautical Society, past President of the Institute of Transport, past-Master of the Worshipful Company of Coachmakers and Coach Harness-makers, Officer of the Order of the Crown of Belgium and of the Legion of Honour (France).

There is always such a satisfaction in seeing a real pioneer come out on top of the particular line which he pioneers. Added to all of which H.P. has the unfair advantage of being one of the most brilliant and outspoken and daring after-dinner speakers that our generation has seen and heard. Also he has the quality of being the supreme propagandist of H.P. products. So that whichever way you look at it he has thoroughly deserved his success.

Finally I think that the supreme test of, and the supreme testimony to, his character is the fact that so many of the present employees of H.P. Ltd. and the men in the top positions have worked with and for H.P. for probably more years than they care to remember. When you come across men in high positions who started with a firm as youngsters and have come to the top you can bet that the head of the firm has pretty sound ideas.

English Electric "Canberra"

By James Hay Stevens, London

The English Electric Co. made aeroplanes during World War I, at the end of which they produced a large flying- boat, designed by W. O. Manning and known as the Phoenix "Cork". Aeroplane production ceased in 1926. When it became obvious that another war was inevitable, the company's Preston works in 1938 were once again prepared for the manufacture of aeroplanes. First Handley Page "Hampdens", then "Halifaxes" and finally de Havilland "Vampires" were built in large numbers, and the latter are still being produced. This experience gave the firm's engineering staff a broad outlook on modern stressed-skin aircraft manufacture, which was widened still further when, in 1944, W. E. W. Petter joined as Chief Engineer of the Aircraft Division. Mr. Petter was the young structural specialist who evolved for Westland Aircraft the "Lysander", "Whirlwind" and "Welkin", each of which, in its own way, was outstanding for original thought in its design.

As World War II drew to its close the English Electric design team started to study the problem of the jet bomber, following up ideas that Mr. Petter had been germinating while still at Westlands. The original conception was for a low-level attack bomber with centrifugal engines mounted in the fuselage. It soon became obvious, however, from the operation of the Gloster "Meteor" and other jet fighters, that a high-altitude aeroplane would make the most effective use of the jet engine. The preliminary design study was submitted to the Ministry of Aircraft production, who then formed the B3/45 bomber specification round it, combining Service needs with design possibilities.

Some of the principal members of the English Electric design team : left to right : F. D. Crowe, Chief Draughtsman; D. L. Ellis, Aerodynamicist; H. C. Harrison, Production Design; A. E. Ellison, Assistant Chief Designer, Development; W. E. W. Petter, Chief Engineer; R. P. Beamont, Chief Test Pilot; D. B. Smith, Senior Administrative Officer; F. W. Page, Assistant Chief Designer, Technical and Projects; H. S. Howat, Ministry of Supply Resident Technical Officer.

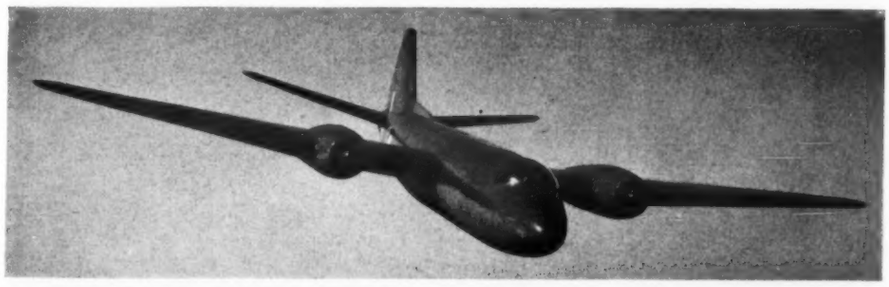
Design Principles

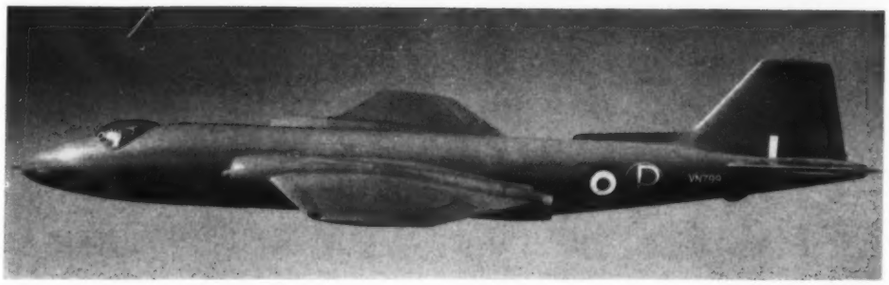
The fundamental principle behind the "Canberra" was a determination to keep the wing loading low; far lower than in most of the jet aeroplanes yet built—although the exact figure may not yet be quoted. With the low wing-loading goes a good altitude performance and with that, of course, the best possible conditions for maximum range. In order to get the large wing area necessary, together with low structure weight, a very low aspect ratio (4.3) was chosen. This was combined with a slender fuselage and nacelles of circular cross-section to keep aerodynamic, and particulary interference, drag to the minimum.

One feels that this emphasis on a low aspect ratio is correct and that it is but the forerunner of others, for a high aspect ratio carries very heavy weight penalties and, at high altitude in particular, reduces lateral control. The return to a saner outlook on wing loading than has been the general case in recent years is also a welcome sign.

Although a high Mach number was aimed at for the operating speed (again, this is not yet released), it was not so near unity as to make completely buried engines or sweepback necessary. The use of nacelles on stalks was dismissed as being unsatisfactory at high Mach numbers: and recent experience in the U. S. A. has proved this to be the case. As soon as the Rolls-Royce axial engine project, now known as the "Avon", was started, the B3/45 began to take shape in its present form.

The general appearance of the "Canberra" prototype can be seen from the photographs and other illustrations. Because of security regulations it is not possible to describe military features, to deal with fuel or engine details, or to publish more than the brief dimensional data given with the general arrangement drawing. The flying demonstration at the S. B. A. C. Display at Farnborough in September last year gave ample proof of performance and manœuvrability. The "Canberra" did, in fact, behave like a fighter, and the take-off and climb were



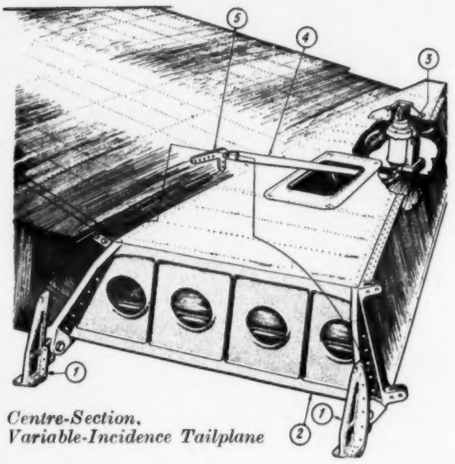


outstandingly better than that of any other jet aircraft shown. When visiting the makers' aerodrome, last November, the author witnessed a further remarkable demonstration by Wing-Commander R. P. Beamont, Chief Test Pilot, given in very bad weather, with rain, low clouds and mist. Despite these bad conditions the "Canberra" was flown at high speed and made several circuits *inside* the aerodrome perimeter at a height of barely 100 feet.

The design work was aided throughout by model studies in the company's own wind tunnels, a 9 ft. x 7 ft. closed return tunnel and a small high-speed tunnel, operated from a "Nene" jet engine, together with full-scale strain gauge tests in a "cathedral" type of test frame. This test equipment is installed at the company's Wharton factory, where the airfield is situated. For flight testing an unusually complete automatic observer is installed in the bomb bay. Between the first flight on May 13th and the end of November, 1949, about 100 hours' test flying was achieved, with full confirmation of performance and handling estimates.

Structual Design

Structurally, the "Canberra" is generally fairly conventional, although in some places there are unusual features. The general principle has been to control weight by having simple shapes and to use a thin skin with closely-spaced stiffeners, instead of following the modern trend toward thicker self-stabilizing skins. This feature comes as rather a surprise, because Mr. Petter was one of the first engineers to adopt a thick skin in his "Welkin" design.



Centre-Section, Variable-Incidence Tailplane

1 Forward hinge on fuselage frame
2 Main spar centre section
3 Electrical actuator
4 Fuselage bracing strut
5 Bracket

The wing is of a thin laminar-flow symmetrical section, with a slightly reflex trailing edge angle, designed by English Electric. With a maximum chord of nineteen feet, the wing is amply thick at the root for structural strength, and provides ample stowage space for the main wheels, while maintaining a good thickness/chord ratio of about 12 per cent. At the wing tip the section is only 9 per cent thick. Each main plane is in one piece and is attached directly to the sides of the fuselage.

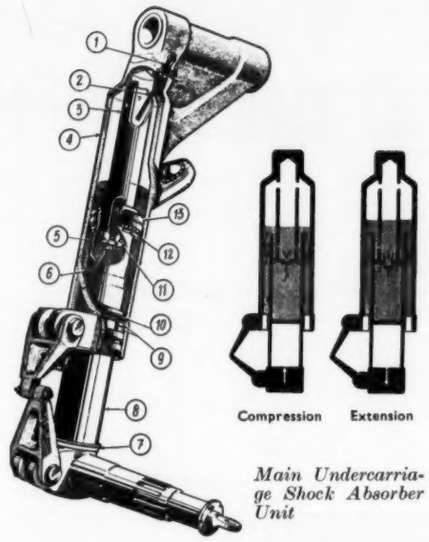
A single spar is used, at about 40 per cent chord, which is built up from massive light-alloy extrusions that are milled down to a T-section to form the booms, the section being progressively reduced toward the tip. The spar webs are solid heavy-gauge light-alloy plates. The ribs are pierced flanged blanks of about 18 s.w.g. light alloy, and they are very closely spaced. Aft of the spar there are two spanwise skin stiffeners to stabilize the upper skin when in compression. The ailerons and flaps are mounted on false spars, and there is another false spar, this time ahead of the main spar, between the fuselage and nacelle to stabilize the wheel well opening. The leading-edge skin, which is only 0.056 in. thick, is put on in panels about three feet wide and running round the nose from the bottom boom of the spar to the top. The tolerance for skin waviness is only 0.002 in. per inch run, and this has been consistently achieved.

The wing is cut back from the leading-edge to the spar for each engine, and there is a large "banjo" in the spar web, consisting of a machined light alloy forging, to allow passage of the jet pipe. The sides of the engine bay are blanked off by sheet ribs having "solid" webs with vertical stiffening channels.

The main planes are attached directly to the sides of the fuselage without wing fillets of any sort, because they are mounted on the diameter, so that the fuselage curves away above and below the wing surfaces. The spar booms are bolted to fittings on the ends of a massive machined light-alloy forging that crosses the fuselage above the bomb bay. This forging acts as a bridge between the spars and is in the form of a double chevron (with the ends and the apices joined by vertical members) that continues the top and bottom booms of the main spar. The flanges of the innermost wing ribs are attached by closely-spaced bolts and anchor nuts to the fuselage skin.

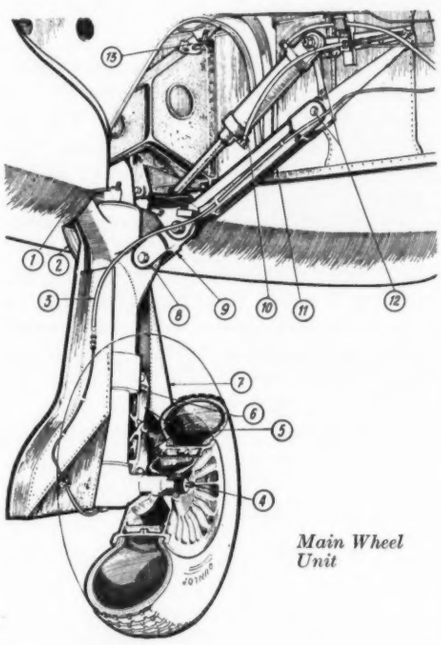
The fuselage is of almost perfect circular cross-section throughout its length and is divided into three sections: the pressure cabin, extending aft almost to the bomb bay; the central portion containing the bomb bay, to which the wing is attached; and the tapering tail section. The structure consists mainly of closely-spaced channel-section frames and multiple longitudinal stringers. There are no longerons, although at more heavily stressed areas there are heavier stringers. The frames in the pressure cabin are of much heavier H-section than in the rest of the fuselage. The whole fuselage nose is attached by quick-release fasteners, even though it forms part of the pressure cabin. The one-piece blown plastic canopy has a double-skin forming a dry air sandwich. Inspection and access panels are generously provided and, in the main, these are attached by set-screws and anchor nuts, although quick-release toggle fasteners are used in some cases.

The bomb bay, which is over twenty feet in length, is interesting because of the bomb doors. In order to increase strength and also to reduce drag and operating loads, these are arranged to slide up into the fuselage on rollers. They are attached to the bomb bay floor, at the aircraft centre-line, by hinged tubes so that the doors swing upward with a radial movement inside the circumference of the fuselage.



Main Undercarriage Shock Absorber Unit

1 Inflation valve
2 Stand pipe
3 Fixed inner tube
4 Outer casing
5 Main orifice
6 Closure control plate
7 Compression stop
8 Sliding tube
9 Sealing rings
10 Extension stop
11 Inner piston tube
12 Rebound orifice plate
13 Sliding tube piston



Main Wheel Unit

1 Inflation valve
2 Outboard undercarriage door
3 Pipe to brake
4 Towing eye
5 Torque links
6 Shock-absorber strut
7 Fixed fairing
8 Spherical joints
9 Side-stay link
10 Undercarriage jack
11 Side-stay
12 Spherical joints
13 Up-latch hook

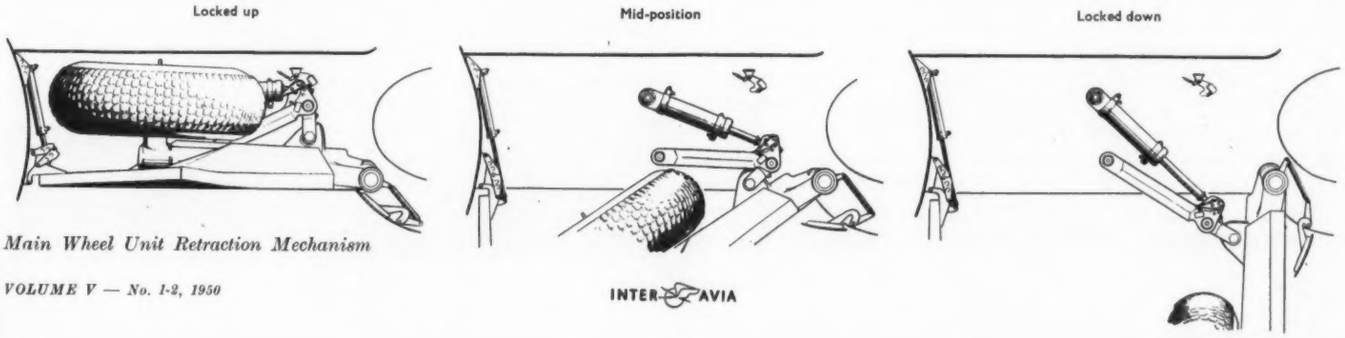
The doors themselves are unusually sturdy, being of a deep crescent section that makes them very stiff. At the S. B. A. C. Display the doors were opened to reduce speed because the prototype was not fitted with air brakes.

The tail unit is consistent in design with the rest of the aeroplane, being of low aspect ratio and of similar thickness/chord ratio to that of the wing. The structure, in general, follows the practice of the rest of the aeroplane, with closely-spaced, flanged-blank ribs and a relatively thin skin. The variable-incidence tail plane is a simple and robust structure, as can be seen from the diagram. The front spars of the two halves of the tail plane are joined by a forging that carries hinges which are mounted on a special fuselage bulkhead. Built back from the forging is the tail plane centre section, triangular in plan form because of the fuselage taper, and the rear part of this is joined to the fuselage by an electric actuator, which raises and lowers the tail plane about the front spar hinges. Rather surprisingly, there are no fillets closing the opening in the fuselage where the tail plane moves, but their absence has caused no trouble in flight. The fin is of partly non-metalic construction so that it can be used to house radio aerials.

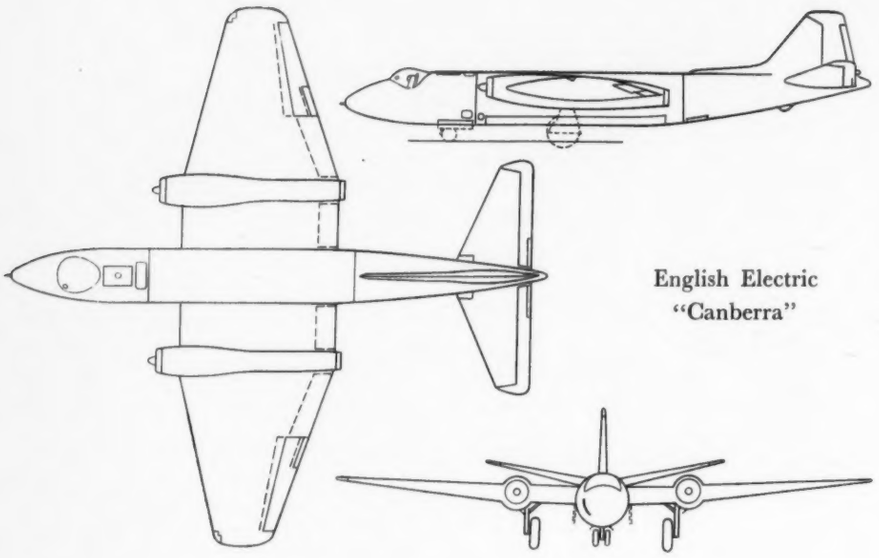
Undercarriage.

The hydraulically-operated tricycle undercarriage is of English Electric design and is not a proprietary item, as is usually the case in Great Britain. The illustrations show clearly the form of the units. The main legs retract inboard into recesses ahead of the front spar the low aspect ratio wing providing ample depth without the use of bulged wheel doors and without restricting leg or wheel sizes. To retract, the jack "breaks" the side strut and draws the knuckle up into the lock on the spar. Fairings are attached to the leg and additional wheel doors are operated hydraulically.

The compression leg is of the double cylinder, oleo-pneumatic type. As the leg is compressed, fluid passes through restrictor holes in the piston heads mounted on the inner and centre tubes. The fluid contained in the middle tube is forced upward and then flows down into the space between the middle and outer tubes, where it is ready for damping the rebound. The



Main Wheel Unit Retraction Mechanism



English Electric "Canberra"

LEADING PARTICULARS

Span	63 ft. 11½ in. (19.50 m.)
Mean aerodynamic chord	15 ft. 0 in. (4.57 m.)
Root chord	19 ft. 0 in. (5.79 m.)
Tip chord	7 ft. 8 in. (2.36 m.)
Length, fuselage	65 ft. 6 in. (19.97 m.)
overall	66 ft. 3 in. (20.20 m.)
Height	15 ft. 7 in. (4.75 m.)
Track	15 ft. 5 in. (4.70 m.)
Tail plane span	27 ft. 5 in. (8.35 m.)
Root chord	10 ft. 0 in. (3.44 m.)
Tip chord	4 ft. 0 in. (1.23 m.)
Fin and rudder chord, root	12 ft. 8½ in. (3.87 m.)
tip	5 ft. 0½ in. (1.54 m.)
Fuselage groundclearance, normal	2 ft. 0 in. (0.61 m.)
Wing area, gross	960 sq. ft. (89.1 sq. m.)
Aspect ratio	4.3
Thickness/chord ratio, root	12%
tip	9%
Main plane incidence	2°
dihedral, inner plane	2°
outer plane	4° 21′
Tail plane and elevator area, gross	171.1 sq. ft. (15.9 sq. m.)
incidence, normal	+ 1°
max.	+ 1° 52′
min.	— 3° 52′
Fin and rudder area, gross	71.22 sq. ft. (6.6 sq. m.)

actual details of the leg are well shown in the drawing.

The nose wheel unit has a liquid-spring lever-suspension shock absorber with self-centering and shimmy-damping devices. The twin wheels are mounted on a trailing arm, as shown in the drawing of the leg and door retracting mechanism.

Flying Controls

The flying control surfaces are conventional, but unusual for a fast aeroplane. The ailerons have sealed pressure balances along the leading edges and are operated through spring tabs. Rudder and elevators have large horn balances and spring tabs. The area of the rudder horn was reduced after the first flight, an operation that had been anticipated. Push-pull tubes carried in self-centering bearings are used for all main control runs. The controls are reported to be unusually light and well harmonized. All controls are fitted with trimming tabs; rudder trim being obtained by adjusting the spring tab through an override mechanism operated by an electrical actuator.

The Mach number trim changes are catered for by the variable incidence tail plane. Although this is low set, its dihedral angle is sufficient to clear the jet streams, and no trouble has been experienced from wing downwash. The dorsal fin on the prototype was a precaution against lack of side area, and flight tests suggest that it is unneccesary, so that it may not be used on production aeroplanes.

Surprisingly, instead of some form of high-lift flap, four rather small split flaps are fitted. Each is operated by a separate hydraulic jack through push rods, bell cranks and toggles.

The dive brakes will consist of a number of "fingers" that can be slid vertically out of the upper and lower surfaces of the wing outboard of the nacelle. They are mounted alongside spanwise skin stiffeners at about mid-chord.

Engine Installation

Little can be said about the engine installation, since the Rolls-Royce "Avon" is still more secret than the aeroplane. The announcer at Farnborough quoted the static thrust as 7,500 lb., but the only official statement gives it as "more than 6,000 lb.".

As already mentioned, the wing leading edge is cut back to form engine bays and into these the engine is mounted. The cowling is in two large main panels, upper and lower, and there is also an underneath servicing panel held by four quick-release toggle fasteners. Engine accessories are mounted on gear boxes in the wing. A stone guard grill is fitted to the annular air intake.

Cabin Installations

On the "Canberra B Mk. 1" the cabin is arranged with an ejector seat to port of the centre-line, with a second ejector seat for the observer immediately behind. The pilot has an excellent all-round view and a small direct-vision panel is fitted in the port side of the canopy. Entry to the cabin is through a door in the lower starboard side of the fuselage. The canopy and a hatch over the observer are both jettisonable prior to using the Martin-Baker ejector seats.

The pressurizing equipment is automatic and is the Normalair system. The disposition of the equipment in the port wing root and the control valve in the pressure bulkhead are shown in the sketch. Air enters a displacement blower from an intake in the leading edge, whence it is led to a mixing valve remotely-controlled from the unit on the cabin bulkhead. From the mixing box three ducts lead to the cabin direct, to the cooler in the leading edge, and to a spill outlet into the engine nacelle. A by-pass duct takes air direct from the leading-edge intake when the pressurization system is not working.

Such, then, is the " Canberra " so far as official restrictions will allow it to be described at the moment. It probably represents the ultimate that can be achieved in performance with conventional design. By the most careful study of aerodynamic form and of the structural design it has proved possible to make a "normal" aeroplane fly as fast, as high, and probably as far, as anything in use today. It is really the story of the "Meteor" all over again. The "Meteor", even in its early days, was a most ordinary aeroplane, yet it proved capable of flight at over 600 m.p.h. with little or no trouble from Mach effects. During the war the German designers were positive that sweep-back alone would make such speed possible. So it is with the "Canberra". The faith of Mr. Petter and his Chief Aerodynamicist, Mr. D. L. Ellis, in their careful work has been fully justified by results. As an example of the design team's exactitude, I was told by a member of the firms that the tare weight of the prototype was 27 lb. less than the estimate!

The Helicopter goes Farming

By Pierre Lefort, Ingénieur A. et M., Paris

One Man, One Horse, One Helicopter

The fact that a demonstration of how the helicopter can be used to exterminate the blossom beetle in a colza field, which one sunny spring day was conducted at Plessis-Belleville, Seine-et-Oise, attracted a large crowd of spectators no doubt is proof that something worth while was going on. A civil servant is easily persuaded to leave his desk to attend an official test. But it takes a lot to convince large numbers of town and country dwellers to give up their Sunday afternoon, the only time when they can pay undivided attention to their own private hobbies, in order to stand around a field and watch. Evidently, "operation colza bug" *was* an important event.

It was important in more than one respect. Chief of all, it was the first large-scale test of its kind ever held in France. It was made possible through the collaboration of Choppin de Janvry, President of Société Française Helicoop, and his pilot, Lecœur, who together had worked out a plan to compare different practical methods of treating a colza field already partly damaged by the beetles. The first item on the programme was performed by a man carrying a simple tank and spray. Walking slowly along the field, he failed to hold the interest of the spectators for more than a few yards. After all, the Twentieth Century is supposed to be the age of speed. The crowd's attention was then aroused by a more rapid and, hence, more efficient operation : a spraying waggon of considerable size, which could be drawn by either a horse or a tractor, went into action. The result was much superior, but by the time the crop was finally cleared of the infernal bugs, the field was damaged by the tracks of the wheels of the vehicle [1].

The impression was created that treating crops in this manner was to fall from the fat into the fire. At that moment an American-built Bell 47 helicopter arrived and carried out a memorable demonstration. Flying low over the colza field, it dusted the crop with hexachlorocyclo-hexane, better known as HCH, which spells certain death to the blossom beetle. To see the helicopter at work was a revelation to many a spectator. The test results were spectacular : at a speed of only 25 miles an hour the helicopter flew parallel courses over the field and covered it completely within a few minutes.

Kaman 190 twin-rotor helicopter in the process of crop dusting.

[1] It should be noted, however, that under the present trends to standardize agricultural equipment increasing use is being made of tractors with large-diameter wheels (about seven feet) of standard track width.

Filling a container with the dusting preparation (Hiller 360).

* * *

Numerous other trials have since been effected, both in France and abroad. As a result, it would appear that the helicopter's services to agriculture may become one of the major factors justifying the existence of the rotary-wing aircraft. In view of its growing importance, it may be useful to consider the helicopter from the point of view of the farmer, who seems destined to become one of its principal customers.

Pest-control pays. It makes possible increased yields from a given acreage, and it improves the quality of the produce. Vines have been sprayed with copper sulphate to combat mildew from times immemorial. Aphids attacking pea cultures and Colorado beetles are exterminated by dusting with DDT preparations; cockchafers, which in certain regions devastate the sugar beet fields, also are successfully combated with DDT or HCH compounds. The farmer knows, too, that 15 percent of his wheat crop is devoured by corn weevils in his barns, unless he previously treats it with DDT. There is no need to mention the plague constituted by locusts. This list could be continued indefinitely.

It is no argument to state that good crops were harvested already in times when pest control did not exist. The loss which farmers in France alone still suffer today as a result of the non-treatment of fields and cultures can be estimated at about 300,000,000,000 French francs a year, or about $750,000,000 at the free market rate. This is roughly one-fifth of the entire French national budget.

The Sikorsky S-51 helicopter and its counterpart built under licence by Westland in Britain are rarely used for agricultural purposes. Photo shows such a four-seater of Helicopter Air Transport on a cross-country flight.

The large British Cierva W.11 "Air Horse" helicopter is shortly to be tested for its suitability for agricultural use.

Slow But Steady Progress

In the Plessis-Belleville demonstration the helicopter was confronted merely with earth-bound means of pest control. In order to obtain a valid basis of comparison, the results obtained by the helicopter should be compared with those achieved with other categories of aircraft, such as a suitably equipped Piper "Cub" lightplane of the type used in Texas for the treatment of cotton fields, in France and North Africa for the protection of vines, in France and the U.S.A. for the dusting of colza crops.

The pilot of an aeroplane or of a helicopter has the dual task to operate, simultaneously, the spraying equipment and the aircraft controls. But whereas an aeroplane cannot fly at speed below 50 m.p.h., the helicopter is capable of flying more slowly. This is the basic difference between the two types of equipment. It is by no means a very safe proposition to pilot an aeroplane at 50 m.p.h. at an altitude of only a few feet and simultaneously to cut in the spraying mechanism without risking a further drop in forward speed. Numerous accidents, most of which have unfortunately proved fatal, are evidence of the strain and fatigue which the performance of this dual duty causes to the pilot.

In addition, the preparation sprayed by the pilot of an aeroplane is spread over a much larger area, particularly in windy or gusty weather. This not only is a waste of valuable material, but also constitutes a hazard to adjoining crops, for numerous preparations are harmless to certain species of plant but noxious to others.

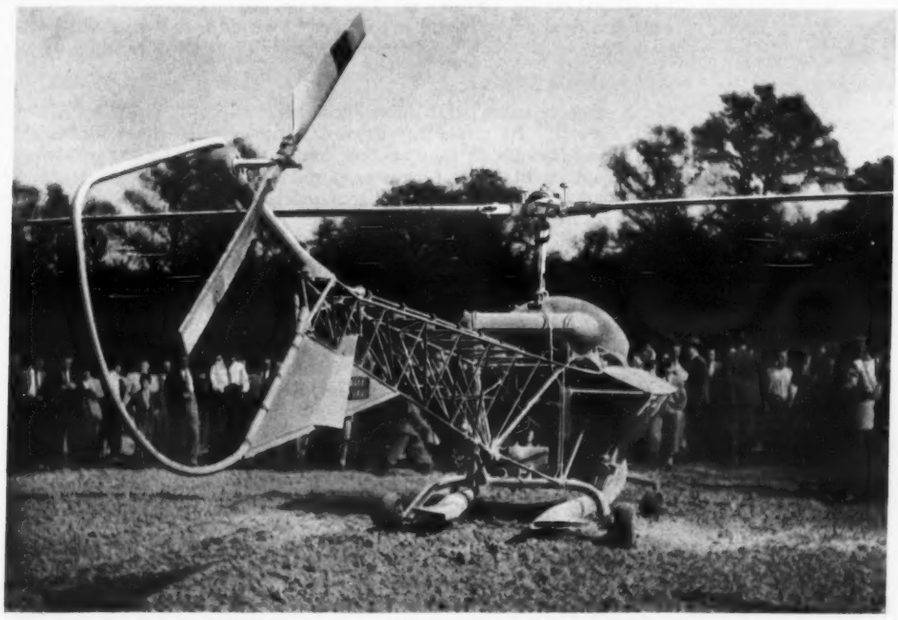
Finally, the aircraft takes a much longer time to accomplish the same amount of work, since in order to turn the aeroplane must fly far beyond the boundary of the field under treatment, which may take up to 70 percent of the entire working time.

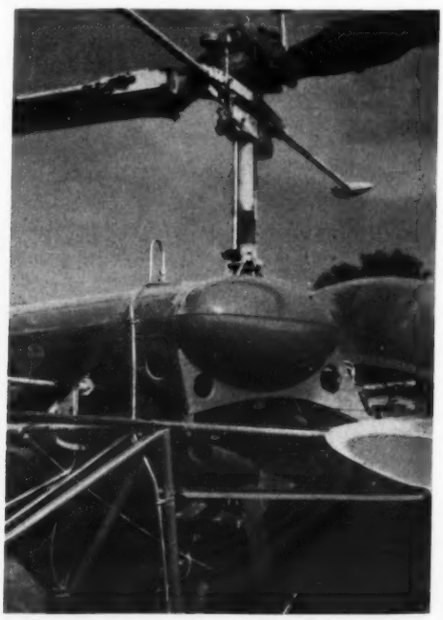
The helicopter is not subject to the hazard of a stall and therefore can fly much more slowly than 50 m.p.h. If necessary, it may even hover on the spot. Another major advantage is that the rotor downwash causes a strong vertical air current, as a result of which the chemical preparation rebounds from the surface and settles also on the underside of leaves and branches. This is easily verified by attaching chemically-prepared paper strips, whose color changes when it enters into contact with the chemical. The photographs reproduced in these pages convey a clear impression of the vertical stream produced by the helicopter rotor. Finally, the inherent characteristics of the helicopter permit the pilot to turn his aircraft immediately at the end of the field, so that only 30 percent of the working period, including landing for refilling, is wasted.

Operating Method

When the treatment of vines against mildew became a current practice, the technique employed was to spray leaves and vines

Agricultural version of Bell 47. Picture on left shows dusting installation, picture on right discloses rotor hub and stabilizer bar.





with a liquid copper sulphate solution by means of a hand pump and nozzle. About 180 lbs. of solution was required per acre so treated. The carriage of such large quantities and the manual operation were too tedious to permit thorough decontamination. Today superior results are obtained with more concentrated preparations, with a consumption reduced to 20 to 45 lbs. per acre. These products, which generally take the form of 5 to 10 percent of active agent compounded with talcum powder or powdered chalk, enable several acres to be covered without refilling the containers.

* * *

The protective preparation can be spread in three ways :

(1) By *spraying*, which consists of the creation of a fine artificial rain carrying the chemical preparation. For this purpose a distributing pipe with numerous nozzles must be fitted to the helicopter at right angles to the direction of flight. The minute droplets emerging from these nozzles adhere more permanently to the plants than dry powder. However, the drops do not rebound from the earth, so that a certain percentage of the preparation is wasted. Nevertheless, the results obtained are excellent even in windy weather. In order to reduce losses through seepage into the earth to a minimum, it is necessary to install a distributing pipe of the greatest practicable length to spread the droplets with a maximum degree of evenness. The length of the pipe should be roughly the same as the rotor diameter.

This method today is employed notably by the British Pest Control Ltd. Its main drawback is the large quantity of spray it requires per acre.

(2) By *dusting*. This is the most widely-used method today. It necessitates a minimum amount of equipment, namely, only two funnel-shaped containers holding the chemical preparation, plus ejector pipes which usually are fitted under the fuselage of the helicopter. Dusting is suitable in most cases where the chemical preparation is inoffensive to neighbouring fields. The very light powder quickly swirls back from the earth and settles uniformly on leaves and branches. The amount of dust required is much smaller than the quantity of liquid needed for spraying.

(3) By *fogging*, which in reality is nothing but spraying with a highly concentrated product (i. e., employment of a small amount of solvent). The most perfect type of equipment so far developed is the atomizer, which produces a poisonous mist consisting of an emulsion of the chemical preparation in a special type of oil; in no-wind conditions this mist remains over the field to be treated for a period of several hours. The particles discharged by the atomizer are no larger than those contained in cigarette smoke.

Fogging has so far been employed chiefly to combat mosquito swarms. A familiar application is the domestic use of manual atomizers against flies, ants, etc., which work on the same principle. Because synthetic hormones form the basic material of this treatment, suitable fogging liquids can be developed only in the course of extensive laboratory tests.

* * *

It seems likely that fogging will assert itself as the most effective method of treating crops. Because the protective preparation is very concentrated, large areas can be treated without refilling, as a result of which the operation can be carried out on a more economic basis.

Nature and Acreage of Crops to be Treated

A list containing the type and acreage of every crop in need of treatment all over the globe would reach astronomical proportions for the non-treatment of any bug-infested culture generally results in the total loss of the crop.

In France alone the following areas should be treated every year, according to official figures :

Potatoes	2,470,000 acres
Colza	250,000 "
Beet	890,000 "
Forage crops	1,980,000 "
Vines	3,460,000 "
Total	9,050,000 acres

On the assumption that a helicopter is capable of 500 hours of flight per year (this figure will probably rise in the course of time) and can treat about 100 acres per hour, European France alone would *in theory* require at least 180 helicopters with a gross weight

"Hiller 360" helicopter fitted with distributing pipe for spraying crops with liquid preparation.

Crop dusting at low altitude with a "Hiller 360".

Fogging with a highly-concentrated liquid preparation in vaporized form.

The new K-225, agricultural version of the Kaman helicopter, is now being tested by the U.S. Air Force. Picture on right shows military equipment: dual controls and radio.

of one ton each (useful load, 440 lbs. each). However, in view of the time required for moving the helicopter from one place to another and from its temporary base to the fields to be treated, as well as for tests and trials, the effective average performance to be expected must be estimated at only about 75 acres per hour of flight. Furthermore, it must be kept in mind that a fleet of 180 helicopters would not be sufficient for the innumerable other useful application of this type of aircraft but would be barely enough for the requirements of pest and insect control.

There is no doubt that additional helicopters could beneficially be employed for forest fire spotting and control. Cost of purchase and operation would be insignificant when compared with the fact that the damage caused by the forest fires which last year raged in the province of the Landes is estimated at more than 5,000,000,000 French francs.

Thus, a fleet of about 200 helicopters would be needed to cover the needs of agriculture of European France alone. This is merely one example. The potentialities of the helicopter in the vast agricultural areas overseas are much more difficult to assess. It must not be overlooked that the helicopter not only is an ideal means of pest control but that in sparsely populated and inaccessible areas it also is a convenient means of passenger and freight transport.

A Brief Calculation

As stated above, extensive pest control could save France the respetable sum of about 300,000,000,000 francs a year. Treatment by conventional means results in about 100,000,000,000 francs worth of crops being saved every year. The shortness of the period available for treatment, the relative slowness of earthbound vehicles used for the purpose (not more than 12 acres per hour) and the impossibility to operate in every kind of terrain exclude a further increase in this performance, so that France has hitherto had to register an unavoidable loss of about 200,000,000,000 francs ($500,000,000) a year.

Assuming the operating cost of the helicopter (including maintenance and depreciation) to amount to 25,000 francs ($62.50) per flying hour, and assuming that 200 helicopters can operate an average of 500 hours each a year, this would result in the following expenditure for European France : 200 x 500 x 25,000 ($62.50) = 2,500,000,000 francs (6,250,000 dollars).

Since the average cost of the bug-killing preparation amounts to 800 francs ($2.00) per acre; and since one helicopter can treat about 75 acres per hour, the procurement of the chemical preparations would entail an expenditure of 6,000,000,000 francs ($15,000,000).

This shows that the total cost of the treatment required by European France would amount to 8,500,000,000 francs ($21,250,000) which is negligible in comparison with the loss of 200,000,000,000 francs incurred by European France year after year.

* * *

In view of the fact that the operating cost of a helicopter is in direct proportion to the machine's weight, preference will be given to the smaller types (with a minimum useful load of 440 lbs.), which will have to land more frequently for refilling (for dusting, once every 12 to 15 acres).

Operating Costs of a Helicopter Used for Crop-Dusting

(in dollars, based on French prices, at the free market rate of about 400 francs to the dollar)

Characteristics of Helicopter : Gross weight 2200 lbs. Useful load 440 lbs. Purchase price $20,000 (8,000,000 frs).

	Hours of operation p. a.			
	250	500	750	1,000
Depreciation (5 years) . .	4,000	4,000	4,000	4,000
Personnel (Salaries and Insurance) Pilot . .	4,500	4,500	4,500	4,500
Personnel (Salaries and Insurance) Mecanic. .	2,000	2,000	2,000	2,000
Aircraft insurance . . .	3,000	3,000	3,000	3,000
Fuel : 6.6.Imp. gals/hr. at 40 mph. (1 gal. = Fr. 225) .	940	1,875	2,815	3,750
Oil (12 % of fuel cost) . .	115	225	340	450
Spares ($2.50 per hour) .	625	1,250	1,875	2,500
Total cost p. a.	15,180	16,850	18,530	20,200
Total cost per hour . . .	60.72	33.70	24.70	20.20
Cost per acre . . . . . (Effective performance) 75 acres per hour	0.81	0.45	0.33	0.27

The use of a large number of small helicopters seems to be advantageous for several reasons :

(1) Experience has shown that the agricultural acreage is divided into numerous lots; the individual areas to be treated are relatively small; and they are distributed over considerable distances.

(2) The first cost of smaller machines can be borne more easily.

(3) In the event of mechanical trouble a reserve helicopter will be more readily available if the total fleet consists of numerous small machines; one mechanic will be able to maintain and repair several helicopters in rotation.

(4) The operation of small helicopters is simpler; it is essential that such aircraft should not be highly sensitive and complicated instruments for special delicate work but that they should be built as robust, easy-to-operate farming implements.

(5) The stock of spare parts, which in each case virtually amounts to a complete helicopter in cannibalized form, will require a smaller capital investment if smaller types are used.

* * *

In conclusion we would draw attention to a paradox in technological progress in this field : in the middle of the Twentieth Century, at a time when faster and faster speeds seem to be the general aim, the slowest of all aircraft offers its services, and it appears to be its vocation to help the old planet's harrassed farmer to obtain a greater yield from his land than ever before.

Agricultural Helicopters

The following survey covers helicopter types of various designs which today are actually available. Reference will also be made to types still under development, provided that they can be expected to be in practical operation in the near future. The reason for the fact that we based the first part of this study on a helicopter weighing about 2,200 lbs. fully-loaded and having a capacity to carry 440 lbs. of dusting material is that helicopters of this general category are already on the market. But the appearance of larger types, such as the Kaman helicopter (with two meshing rotors) of about 2,900 lbs. gross weight with approximately 700 lbs. of useful load cannot be overlooked.

Experience will show which of all these types is the most suitable. However, such experience, even with types currently available, can be gained only if authorities and agricultural organizations make up their minds to carry out extensive tests and convincing demonstrations. It will be up to them, at least at the beginning, to show the farmer the benefits he can derive from this unconventional type of farming equipment.

Hiller 360

The "Hiller 360" helicopter, which is now being produced in the U.S.A. by United Helicopters Inc., under the direction of Stanley Hiller, is available in a special agricultural version. Normally the type is a side-by-side three-seater, powered with a 178 h.p. Franklin engine. Approved gross weight is 2,247 lbs., and on a one-hour flight it is capable of carrying 550 pounds in addition to the pilot. Pitch changes of the two main rotor blades are effected by a servo rotor, the blades of which are controlled by movements of the control stick ("Rotormatic Control"). The "Hiller 360" owes its inherent stability to the special airfoil section of the servo rotor blades. Several other innovations have greatly simplified its design : epicyclic gear drive with only three planet wheels, fiberglass-covered wooden blades, automatic mercury coupling weighing less than 13 pounds, tail rotor of metal monocoque construction and semi-monocoque fuselage.

It is possible to install either dusting, spraying or fogging equipment. Two containers, each having a volume of 57 Imp. gals. and holding 275 pounds of dusting powder or spraying liquid, are fitted to the fuselage sides; only the dusting, spraying and fogging devices are different in each of the three cases.

For dusting purposes the distribution is regulated by a device mounted behind the engine and adjustable on the ground; it is switched on or off by push-button on the control column.

For crop-spraying two pipes projecting at right angles from the fuselage sides are used. They measure 15 ft. 7 in. in length and are provided with 16 spraying nozzles each. The liquid pressure can be adjusted manually on the ground, without special tools, within a range from 0 to 140 lbs./sq. in.

Since the two containers are interconnected by a wide funnel, the liquid can be poured in from one side for both tanks; a stirring mechanism built into the containers maintains the spraying mixture in constant motion.

For fogging, the liquid is injected through a nozzle into a special pipe branching off the exhaust and vaporized. The supply of about 44 Imp. gals. is sufficient for about one hour's flying and permits the fogging of about 300 acres.

Bell 47

The Bell 47 helicopter, built by the Bell Aircraft Corp., of Niagara Falls, N. Y., is also available in a version designed for agricultural work, the Bell 47-D-1.

The normal version is a two-seater and is also powered with a 178 h. p. Franklin engine. Adapted for crop dusting duties it has a weight empty of 1,482 lbs. and a total useful load (including the pilot) of 718 lbs. As in the case of all Bell helicopter models, a stabilizer bar is articulated below the rotor and revolves together with the latter. Weights are attached to the end of the bar. In the manner of a gyroscope it tends to revolve in an unchanged plane of rotation, independently of the position of the rotor axis; this improves the control characteristics and facilitates the operation of the aircraft.

The rotor has a diameter of 35 ft. 2 in. and features two fiberglass-covered wooden blades, on an articulated hub. To reduce weight the rear fuselage structure is not covered. Like the "Hiller 360", the Bell 47-D-1 is suitable for dusting, spraying and fogging.

Kaman K-190

This helicopter has two twin-blade rotors, whose planes of rotation overlap and cover a total width of 38 ft. Power plant is a Lycoming engine of 190 h. p. The normal three-seater version has a gross weight of 2,500 lbs., including 720 lbs. for pilot and useful load.

An improved agricultural version, the K-225, differs from the normal model by a more powerful engine (225 h. p.), which permits an increase in gross weight to 2,900 lbs. and in useful load to 1,100 lbs. With a view to adapting the basic type to agricultural work, both versions feature an open framework fuselage.

The main characteristic of the Kaman helicopters are the servo control flaps fitted to the tip of all rotor blades; they are adjustable for collective or cyclic pitch changes. The pitch of the blades themselves remains virtually unchanged. In cooperation with deflections of the rudder, the cyclic change of the servo control flaps also permits the helicopter to revolve about its vertical axis. Since the two rotors compensate each other's torque moment, the usual tail rotor is unnecessary, which is an advantage because it absorbs 10 to 12 percent of the engine output and is a hazard to man and beast on the ground.

The Kaman helicopter, whose manoeuvrability and control characteristics are greatly appreciated by pilots and have been featured in numerous propaganda films, is also fitted with interchangeable equipment for dusting, spraying and fogging.

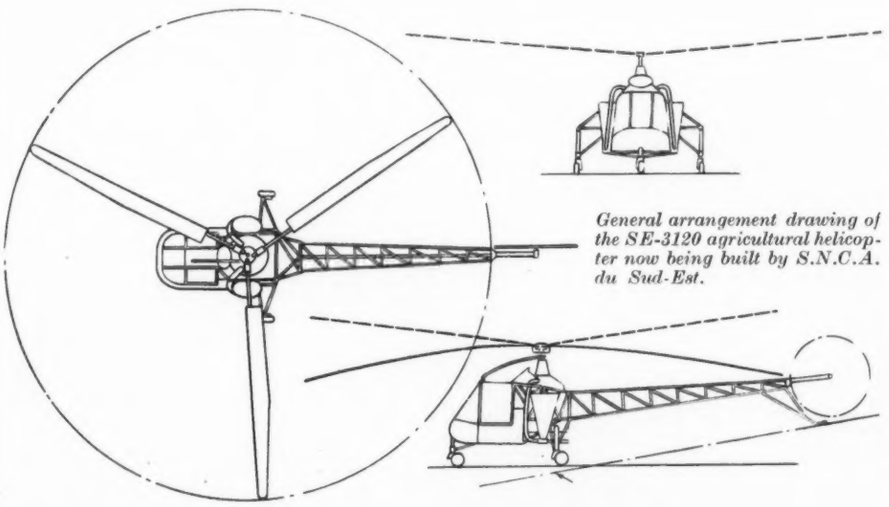
Sikorsky S-51

The Sikorsky S-51, which is employed largely by Britain's Pest Control Ltd., is a fairly large helicopter. It has a gross weight of 5,200 lbs. and a disposable load of 1,250 lbs. Its three-blade rotor, which has a diameter of 48 ft., is driven by a vertically-mounted Alvis "Leonides" radial engine of 550 h. p. Although it can be equipped for dusting or fogging like other helicopters, it is used chiefly for spraying of fields. Its 36-ft. spraying pipe, mounted at right angles to the direction of flight, has about 50 nozzles, and the two fluid tanks have a capacity of 42 Imp. gals. each. Units of this size will be employed only for the treatment of very large areas.

Although the normal version is fitted for several passengers, the pilot is usually the only occupant when the aircraft is engaged for agricultural work.

Cierva W-11 "Air Horse"

With its W-11 "Air Horse" the British Cierva Autogiro Co. has built a large helicopter having an all-up weight of more than 7 tons. It is now undergoing tests. Its three rotors revolve in the same direction in order mutually to increase the spiral effect of their downwash. For agricultural purposes a long distributor pipe fed from a 500-Imp. gal. tank is to be fitted. A valid assessment of the utility of the type will be possible only upon the termination of suitable tests.



General arrangement drawing of the SE-3120 agricultural helicopter now being built by S.N.C.A. du Sud-Est.

SE-3120 of the S. N. C. A. du Sud-Ouest

As a successor to the SE-3110 two-seater, which was exhibited at the last Paris Aircraft Show, S. N. C. A. du Sud-Est is now building a three-seater designed especially for agricultural work. The machine is designated SE-3120. Its three-blade rotor of 38 ft. 1 in. diameter is driven by a 200 h. p. Salmson radial engine mounted upright, like that its predecessor.

The fuselage features an open steel tube framework carrying a single tail rotor at its extremity, in place of the two rotors mounted in "V" shape of its predecessor. This results in a considerable simplification and weight economy without impairing the flying characteristics.

Including its special agricultural equipment, the SE-3120 has an empty weight of 1,610 lbs., with a pilot, 420 lbs. of dusting material and fuel for one hour it has a gross weight of 2,315 lbs;

The dusting equipment comprises two containers holding a combined total of 420 lbs.; distributing device and ejection chutes. For spraying work two tanks with pumps and nozzle pipes are fitted.

Aerodynamic Forces on the Parachute

By Wilhelm Seibold, Paris

Many an airman has arrived back on *terra firma* wondering why he did *not* break his neck or why he *did* sprain his ankle. In most cases curiosity does not probe beyond that point. Why worry any further? The parachute will save the airman even if his knowledge is limited to the ripcord which he must pull. Apart from that, regarded from the point of view of aerodynamics, the parachute is a very complex device, the shape of which is determined in part by aerodynamic forces. Nevertheless, it is possible to lay down certain principles illustrating the play of the airflow affecting the parachute.

In its classical form the parachute is tailored in circular shape. It consists of several gores connected with each other by radial seams; Fig. 1 shows diagrammatically the cut of an airborne infantry parachute. The model in question is made of pure silk with a degree of porosity resulting in 4 cu. ft. of air passing through each square foot of parachute fabric per second under a pressure differential equivalent to a 0.63-in. water column. A parachutist weighing a total of 220 lbs. with full equipment would descend to the ground at a rate of about 20 ft. per second. The parachute would assume its familiar shape, which roughly corresponds to a flattened rotational ellipsoid, the largest diameter of which amounts to about two-thirds of the tailored diameter [1]. In the apex of the parachute there is a vent; the air spilling through this vent from the interior tends to counteract the pendulating motion of the parachute.

There is a widespread view that in still air such a parachute descends vertically to the ground. Careful observation shows, however, that the parachute either pendulates or follows an irregular trajectory which is always deflected through about 45 degrees from the vertical [2]. In order to obtain valid observations, a vertically-descending parachute of identical mean rate of descent was dropped simultaneously with the infantry parachute. Over a large portion of the downward trajectory the infantry parachute moved in a spiral about the vertically-descending model, and over the entire course the 45 degree inclination from the vertical—known as drifting or crabbing—was clearly evident. In order to eliminate wind and gust effects, models having a diameter of about 40 in. were dropped in the interior of an empty gasometer. The observations cited above were confirmed, but the tendency to pendulate was smaller. It seems that the direction of descent is determined by small asymmetries in the parachute shape which constantly changes

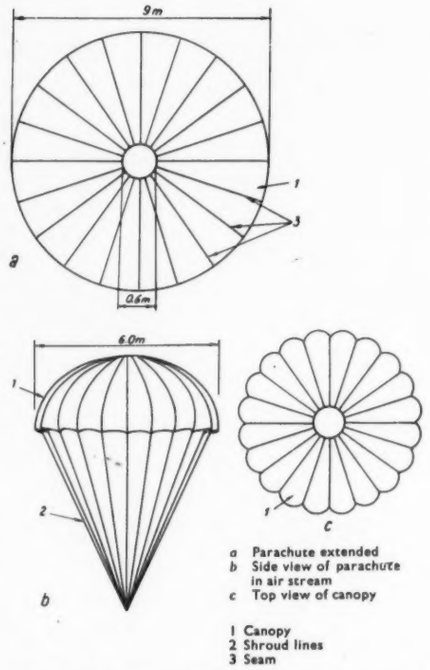


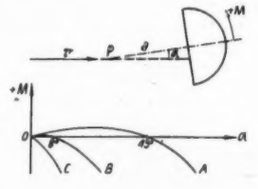
Fig. 1: Infantry parachute.

within narrow limits. The result is a dispersion of the landing points. It is possible to calculate that an average of 50 percent of all parachutes dropped at one point will land within a circle whose radius is about one-fifth of the dropping-height. This circle is necessarily displaced laterally from the dropping-point, depending upon wind conditions.

Thus the jumper suspended from his parachute will generally hit the ground at an angle, even in still-air conditions, and it requires considerable agility to eliminate the harmful effect of this horizontal speed by skillful rolling of the body on the ground. It is a fact that inexperienced people, for example in the case of emergency jumps, very frequently sprain their ankles. One great advantage can be obtained by ensuring that the horizontal speed during the descent runs in the forward direction, as is the case of a man jumping off a vehicle in motion. This is achieved largely with the well-known Russian rectangular parachute which is designed so as to be not entirely symmetrical [3]. Otherwise the Russian model has the same general characteristics as the parachute described above; it has the advantage of causing a smaller degree of wastage in manufacture, due to the fact that its gores are rectangular.

In order to determine the behavior of parachutes, a start was made with metal sheet models in a wind tunnel. Their shape was patterned after that of full-scale parachutes in descent. Obtained was the moment curve *A* illustrated in figure 2, the moment referring to the shroud line knotting point *P*. The overall centre of gravity of the parachute and its load is close to this point. At an angle of attack of $\alpha = 0°$ the model maintains a labile equilibrium; between 0° and 45° a slight moment directed away from the zero position is obtained, whereas at more than 45° there results a strong rearward moment. On the whole, therefore, the model is virtually indifferent between 0° and 45°. This result was verified with 6 to 10-foot diameter fabric models in a 26-foot wind tunnel (Brunswick) and in a 52-foot by 26-foot wind tunnel (Chalais-Meudon). The parachutes were also held captive at the shroud line knotting point *P* (fig. 2) and swung from side to side in the air stream within a cone of twice 45°. Since the air stream was horizontal, the effect of the parachute's weight manifested itself by the parachute's more frequent presence in the lower portion of the angle just described; however it did occasionally rise also to the highest point of this angle. Confirming the moment curve established with the metal sheet model, it was even discovered that the parachute mostly stayed within the bordering area of the cone and only very rarely traversed its interior. The drag coefficient, referred to the maximum cross sectional area in the air stream, is about $1\ 1/3$, which corresponds to the observed mean rate of descent.

This behaviour of the parachute can be explained as follows: — As soon as the parachute attains an angle of attack α (fig. 3)



A Tailored, circular infantry parachute (fig. 1)
B Ribbon parachute (canopy of ribbons sewn crosswise together)
C Stabilizer parachute (with special stabilizing lobes, fig. 4)
a Parachute's axis of symmetry
v Direction of wind
α Angle of attack
P Shroud line knotting point
M Moment, as referred to knotting point P

Fig. 2: Moment curves for different parachutes.

[1] Cf. "*Interavia*, Review of World Aviation", No. 11, November, 1948, page 606, photograph at bottom left.
[2] *Op. cit.*, page 605, upper photo.
[3] Cf. "*Interavia*, Review of World Aviation", No. 10, October, 1949, page 597, top photo.

in relation to the air stream, a velocity increase occurs on the side inclined towards the stream, which results in a suction tending further to deviate the parachute. At the same time the high pressure area displaces itself to the same side and produces a rearward-acting moment. At about 45° the two moments attain an equilibrium, and it is at that point that the parachute reaches its position of stability. Since a high-pressure condition prevails in the interior of the canopy, the parachute roughly maintains its shape.

In order to eliminate this undesirable suction, the airflow must be prevented from following the contour of the canopy. This can be achieved by inserting vents in the canopy, so that the air spilling from the interior causes the outside airflow to break

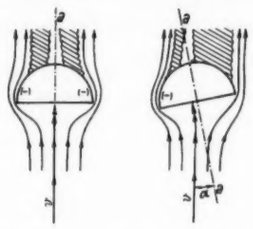


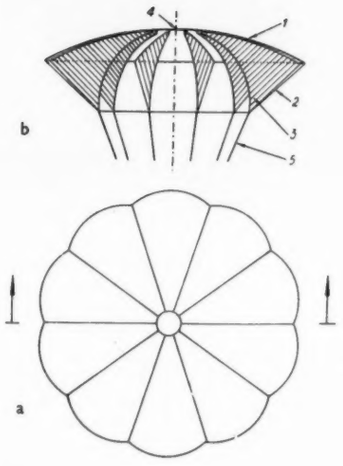
Fig. 3 : Air flow around the circular parachute.

The high-pressure area is indicated by a double arrow (→→), the dead air region by shading and the low-pressure by —.

away. As one of the most important embodiments of this idea, Madelung and his collaborators built the so-called ribbon parachute, the sail of which consists of ribbons approximately two inches wide and sewn together in such a way as to provide apertures totalling about 30 percent of the total surface. Measurements of the moment produced the curve *B* charted in figure 2. The maximum pendulating deflection was 8°, and the drag coefficient of the parachute amounted to only 1.0. The ribbon parachute was heavier than the infantry parachute previously described, but in addition to better stability and somewhat lighter opening shock characteristics it featured a major advantage in its very great strength, which makes it suitable for a variety of purposes. Ribbon parachutes have therefore been developed for heavy loads, high speeds and for braking aircraft after touching down.

For very high stability requirements a parachute with a series of openings in its canopy, such as the ribbon parachute, is not sufficient. As an aid to stability, Dr. Ing. H. G. Heinrich [4] therefore fitted stabilizing lobes to his parachute (fig. 4). The moment curve *C* given in figure 2 was thus obtained, which represents full stability in the zero position but furnishes a drag coefficient of only about two-thirds of that of conventional infantry parachutes. Shape is maintained by fabric stiffening frames. Its stability is so good that in many cases it was used to replace the unwieldy fin units of conventional bombs and supply containers, as a result of which the volume of bombs was reduced by about 30 percent. In this application, the tail of the bomb and the parachute were held together by a curious arrangement of shroud lines (fig. 5). The porosity of the fabric employed was somewhere between

[4] Wartime Director of the "Graf Zeepelin" research institute near Stuttgart.



a Top view
b Cross section

1 Canopy 2 Stabilizinglobe 3 Radial fabric frame (shaded) 4 Apex 5 Shroud lines

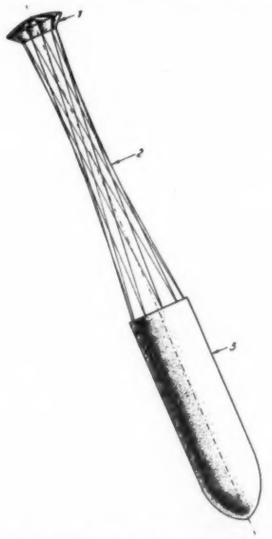
Drawn is the shape to which the parachute is sewn. The vent in the apex facilitates manufacture but is unnecessary from the point of view of aerodynamics. In the air stream the parachute retains its design shape, and merely the edges become slightly rounded off.

Fig. 4 : Stabilizer parachute (Cf. fig. 5).

1.2 to 2 cubic feet of air per square foot of fabric per second.

A particularly important problem is posed by the so-called opening shock, which is the maximum force occurring during the opening process of the parachute. The force of the shock is frequently also defined by the maximum degree of deceleration that is achieved.

The opening process of the parachute is divided into two phases : following the opening of the parachute pack the canopy is borne rearward, fre quently with the assistance of a small pilot parachute, until its shroud lines are suddenly jerked taut. This produces what may be called the extension shock. The transmission of this shock to the load is diminished by the elasticity of the shroud lines and frequently by additional shock absorbing

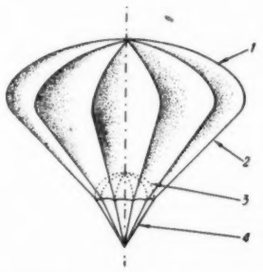


1 Canopy (fig. 4) 2 Shroud lines (they form the two sets of straight lines of a one-sheet rotational hyperboloid) 3 Container

Fig. 5 : A supplies container steadied by means of a stabilizer parachute.

aids. The air now begins gradually to fill the canopy, thus increasing its drag coefficient. Within a brief period of time (1 to 2 secs.) the parachute is greatly slowed down. The maximum force occurring in this filling and retarding process is called the opening shock in the most narrow sense; in general the extension shock is smaller than the opening shock. The human being falling freely through the air creates a ram pressure of nearly 41 lbs. per square foot, which corresponds to a sea level terminal velocity of about 180 ft./sec. If the circular type parachute described above is released at this ram pressure, the maximum deceleration to be reckoned with is three to four G.

Many efforts have been made to diminish this opening shock. Mechanical dampening devices have frequently been employed. A very effective means is initially to prevent the canopy from opening out freely by constricting it at its base with a special line. The canopy is fully released only at a later stage. This "reefing" of the parachute has been employed with great success. Complete elimination of the extension and opening shocks would be possible by fitting a braking device which extracts the parachute from its pack very slowly and allows it to open gradually. No sufficiently simple designs have as yet been evolved, however. Heinrich has designed a parachute which owing to its very small influx area opens very slowly and therefore produces a negligible opening shock (fig. 6). The extension shock of the parachute is equally unimportant owing to the use of short shroud lines.



1 Canopy 2 Stabilizing lobe 3 Inset 4 Shroud lines.

The canopy is made of virtually impermeable fabric, the inset of porous fabric.

Fig. 6 : Parachute with minimum opening shock.

For the use of human beings these means of diminishing the opening shock do not seem adequate. The main difficulty, particularly in the event of emergency jumps by air crews, is that in high-speed aircraft the jumper finds it impossible to escape from his machine. To overcome this obstacle, ejector seats or similar devices are employed [5]. Directly after the ejection of the seat, a small pilot parachute opens out to prevent the aircrew member and his seat from somersaulting and slows down their descent until the opening of a conventional parachute can be risked without hazard. In the case of jumps from very great altitudes (over 30,000 ft.) it seems indicated to allow the jumper to fall free for a very considerable distance, in order to shorten the period of exposure to extreme cold and lack of oxygen. The main parachute is opened only at relatively low altitude by means of a barometeric release mechanism.

[5] Cf. "*Interavia*, Review of World Aviation", No. 1, January, 1947, pages 51-54.

Turbojet Intake Configurations

By A.W. Quick *(Continuation and Conclusion)*

5. *Adapting the intake to the flow conditions of a swept wing*

It is a fact that the aerodynamic qualities of an aircraft wing deteriorate considerably as sonic speed is approached. The use of swept wings enables the initiation of this deterioration to be deferred to highers peeds — a circumstance attributable to the particular structure of the flow past swept wings.

Fig. 23 shows schematically the flow around a drifting wing of infinite span, the sinuous course of the streamlines in the plan view

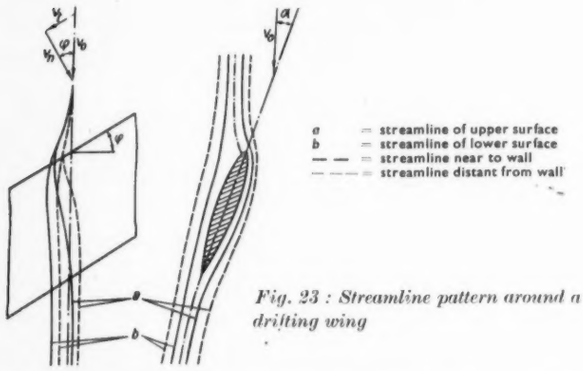


Fig. 23 : Streamline pattern around a drifting wing

being the particular characteristic of this type of flow. This pattern is easily explained by the fact that only the component v_n (perpendicular to the wing) of the flow speed v_o gives birth to a variable local speed in wing proximity, whilst the component v_t tangent to the wing is constant throughout the region. In consequence, the flow gradients in wing proximity are likewise variable in plan view, though this is not, or hardly, the case for a straight wing ($\varphi = 0$). It is clear, therefore, that the flow lines' deviations from direction of relative flow increase the nearer the flow line under consideration lies to the wing upper surface. Furthermore, it follows that, presupposing an aerofoil of symmetrical section, the flow lines above the wing must differ all the more from those beneath it as the angle of incidence increases. Also, changing the Mach number of the relative flow will influence the flow pattern. For not too high Mach numbers this variation may be calculated approximatively, in a simplified form, by means of the Prandtl-Glauert equation. At Mach numbers approaching unity, however, it is necessary to resort to other methods.

We know, on the other hand, that the initiation of aerodynamic deterioration is solely due to the component $v_n = v_o \cos \varphi$, taking effect once this component begins to approach sonic speed. This explains why on a drifting wing this deterioration is deferred until higher Mach numbers are attained. We find this effect, peculiar to the drifting wing, on the swept wing (Fig. 24), but it is localized in the external portions, for in the centre section there arises a perturbation due to an interaction of port and starboard wings such that the streamlines' lateral deviations diminish ever more as the plane of symmetry is approached, annulling completely when this plane is reached. It follows from this that the swept wing's centre section does not behave as a drifting wing (as in Fig. 23) but, for instance in the actual centre, approximates the behaviour of a straight wing. It is evident, therefore, that in the plane of symmetry there takes birth a more or less extended region in which the advantage offered by the drifting wing is only partly, or not at all, obtained.

In the following paragraphs it is aimed to describe how this disadvantage of the swept wing may be partly eliminated in an aircraft of classical layout — *i.e.*, with fuselage. To this end let us imagine a wall *P* in a plane *A-A* applied to a drifting wing of infinite span (Fig. 25*a*), this wall being parallel to the direction of flow, perpendicular to the plane of the diagram, and cambered in wing proximity according to the streamline contours. In the case of frictionless flow this wall would have no influence on the flow past the drifting wing. We may now leave out the starboard wing and draw up the port wing of Fig. 25 *a* to the corresponding starboard half of the mirrored drifting wing shown in Fig. 25 *b*, until the two walls meet (Fig. 26). This contact takes place in the rear part of the wing; between the two walls there arises a space which, far in front of the wing, has the width *a* and would have to assume the form of a body of displacement in order for the swept wing to feature at every point the flow pattern peculiar to a drifting wing of infinite span.

In general, the width *a* will not be very great in relation to the wing chord, and it will be appreciably smaller than the width of fuselages of usual dimensions. We may now draw the two planes

* Cf. "*Interavia*, Review of World Aviation", Vol. IV, No. 11, pp. 679-684.

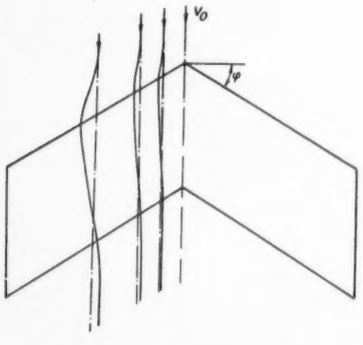


Fig. 24 : Lateral streamline deviations from swept wing.

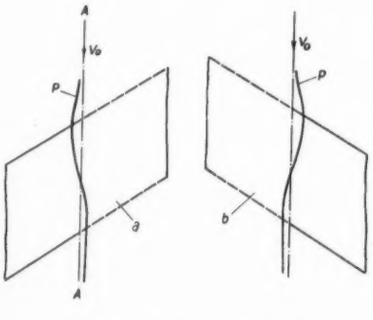


Fig. 25 : Streamline wall for swept wing.

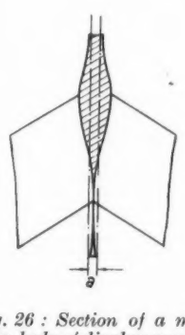


Fig. 26 : Section of a minimum body of displacement for a swept wing.

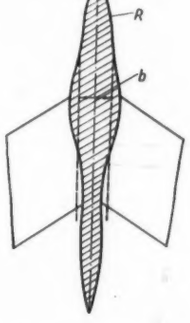


Fig. 27 : Section of a fuselage for a swept wing.

away from each other and thereby increase the minimum width a to values corresponding to the usual widths of fuselages (Fig. 27). The resulting body of displacement R must now extend to far beyond the wing in order fully to achieve the goal sought. In any event we may suppose that the most important thing is to have the streamline pattern in wing proximity follow the fuselage contour, and that a deviation, whose influence disappears according to its magnitude and distance from the wing, is admissible at a greater distance away from the wing.

For example, it is certainly admissible to modify the form of the body of displacement at a certain distance aft of the wing, having it terminate in a point. In front of the wing, too, nothing very noticeable would happen if the fuselage were made very gradually to terminate in a point. On the contrary, the major difficulty lies in the fact that the height of the fuselage is small in relation to the wing chord, making it impossible to reproduce the theoretical streamline pattern except in immediate wing proximity. The wing will often be found to lie below the fuselage centre-line, leaving little fuselage height available beneath the wing and an excess of fuselage height above it. This inconvenience is partly offset by the fact that, as the lift coefficient increases, the required bulging of the lateral fuselage increases above the wing and decreases below it. Suitable warping of the wing would offer a further possibility of reducing the required bulging on the lower part, thereby adapting matters somewhat more to the given conditions. Meanwhile, also here we may conclude that the most important region is that in immediate vicinity of the wing, so that an appreciable part of the possible gain may be realized.

In order to give an idea of the magnitude of the streamlines' lateral shifts, Fig. 28 shows the streamlines for a drifting wing with a section of 12 percent thickness and a 33-deg. angle of drift, and for a Mach number $M = 0.85$.[1] In this case the minimum width a of the body of displacement is raised to about 4 percent of the wing chord; in other words, a fuselage of mean width b (Fig. 27) would taper at the most by 4 percent of the wing chord, at a distance of 85 percent of the wing chord aft of the wing leading edge. In the front part, on the other hand, we would obtain a widening which, for the streamline at a distance away from the wing contour amounting to about 2.5 percent chord, would attain, for example, 14 percent of the chord, increasing to infinity as it approached the wing, a circumstance immediately recognizable from a comparison with the pattern of the stagnation streamlines. However, this pattern occasions no particular difficulty. Primarily, it brings to light the tangential penetration of the side wall of the fuselage into the wing surface, having the effect of rounding off what would other wise be a corner. Thus, all along its line of intersection with the wing, the side wall of the fuselage acquires such bulges, so that there automatically results a special type of wing-fuselage fairing. Fig. 28 shows a few sectional views, from which the form of these fairings is recognizable. Lastly, it should be noted that such roundings of the fuselage walls are likewise obtained in front and aft of the wing, thus assuring a steady transition at the leading and trailing edges.

As already stated above, the considerations presented here apply to frictionless flow. Replacement of the streamline wall by a material wall gives rise to a boundary layer owing to the air's adherence to the wall. This boundary layer repels the streamlines near the wall by a distance called the displacement thickness, symbolized by δ^*, which is defined as follows :

$$\delta^* = \frac{1}{v_a} \int_0^{\delta} (v_a - v)\, dy$$

where (see Fig. 29) :

v_a = speed outside boundary layer,
v = local speed inside boundary layer,
y = coordinate orthogonal to the wall,
δ = total thickness of boundary layer.

[1] The streamlines of the incompressible flow are calculated by the method of G. Rossner (*Jahrbuch 1942 der Deutschen Luftfahrtforschung*) and those of the compressible flow are determined by means of the Prandtl-Glauert equation.

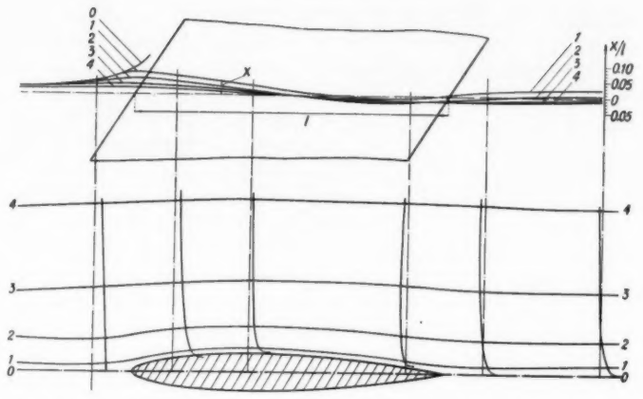


Fig. 28 : Streamlines for a drifting wing at $M = 0.85$ *and* $C_L = 0$. *Above, plan view; below, elevation showing cross-sections (valid for configuration of fuselage side wall).*

The value of δ^* must be taken into account when designing the fuselage contour, *i.e.*, the fuselage width diminishes by this amount (Fig. 30). Meanwhile, it is conceivable that the pressure prevailing in the streamline wall may undergo considerable local increases which, in the presence of the material wall and, consequently, the boundary layer, would substantially increase the thickness of the boundary layer, going so far as to incite its break-away. Points where this can occur must be investigated very carefully and, as the case may be, eliminated by boundary-layer suction.

The foregoing considerations of the formation of flow past swept wings may now be applied to the judicious adaptation of the jet engine intake to this type of flow. Fig. 31, which treats of the example of an intake above the wing, shows the approximate form an intake must have in order to profit most by the above considerations. The contour r of the fuselage, patterned after the streamlines of the flow past the swept wing, is subjected at the level of the intake to a lateral displacement by the amount e and subsequently follows again a streamline pertaining to the swept wing; e represents here the thickness of the layer of air flowing into the engine. A short distance aft of the intake, the interior of the channel no longer needs to follow the streamline pattern of the swept wing, but may be designed along other lines which satisfy other requirements. Since this applies to all intakes of fixed cross-section, this solution, too, is subject to difficulties, occasioned by excessive speeds of flow past the "nose" of the opening when the flying speed is varied, because the

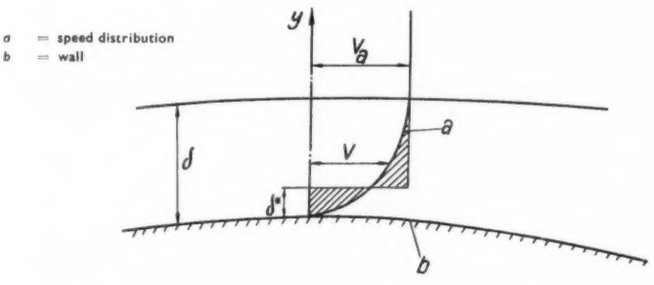


Fig. 29 : Displacement thickness of boundary layer

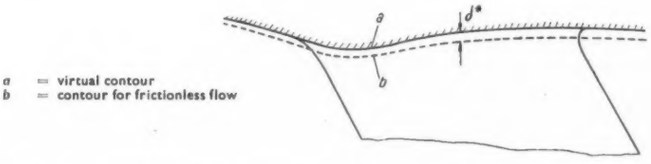


Fig. 30 : Modification of fuselage contour by boundary layer

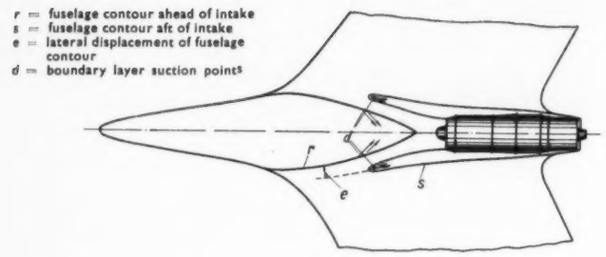


Fig. 31 : Intake above swept wing.

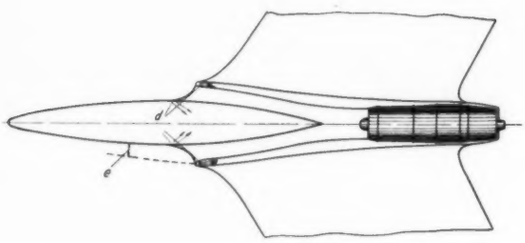


Fig. 32 : Intake upstream of swept wing.

thickness e of the in-flowing air layer varies and, in consequence, the flow stagnation point at the nose shifts. Here also, a variable cross-section would lessen the difficulties; moreover, boundary-layer suction applied in the vicinity of the shock wave eventually occurring at the nose would attenuate its unfavourable effects on the downstream flow. Again, boundary-layer suction would also be necessary in the region d in order to avoid losses due to break-away.

Another possibility, with the intake placed forward of the wing leading edge, is presented in Fig. 32. Here the lateral fuselage contour in wing proximity follows the swept-wing streamline, and the above-mentioned shift of the streamline by the amount e takes place in front of the wing. Boundary-layer suction in the region d, and a variable intake cross-section, would eventually cut down losses due to break-away and shock waves.

6. *Intakes for supersonic aircraft*

Flying speeds increased to supersonic speed also entail new problems with respect to the intake configuration. Assuming that the engine should continue to work under conditions of subsonic flow, there arises the task of transforming the supersonic flow into subsonic flow. It is common knowledge that such a transformation cannot be accomplished by the simple methods applicable to subsonic flow, for there is need to take into account the almost inevitable shock waves which arise, incurring, among other things, a loss in total pressure.

The simplest case is when the supersonic flow is led back to subsonic conditions through the normal compressibility shock, *i.e.*, the shock wave perpendicular to the direction of flow. When piercing the shock plane, the values of pressure, speed, density and temperature change very suddenly. Solely the total temperature remains unchanged. The resultant relationships of total pressure, speeds and Mach numbers aft of the shock to those in front of the shock are plotted in Fig. 33. It can be seen that, below $M = 1.4$, the total pressure aft of the shock amounts to more than 95 percent of the total pressure in front of the shock, so that the loss is within acceptable limits. On the other hand, the pressure ratio P_2/P_1 diminishes rapidly, amounting to only 72 percent at $M = 2$ and as little as 32 percent at $M = 3$. At speeds about $M = 1.4$, therefore, other methods must be found in order to reduce the losses due to the shock wave.

In this respect, the oblique shock waves provide a possibility. In this case, the plane of the shock is inclined at an angle φ to the perpendicular to the direction of flow. Here, too, the speeds change very suddenly as the plane of the shock is pierced—though this applies only to the components located perpendicular to the plane, so that the stream-lines feature an inflection. Furthermore, it may be seen that, according to the magnitude of the shock wave's inclination, the speed downstream of the oblique shock can be either supersonic or subsonic. The losses depend only on the component perpendicular to the shock plane, $M_1 \cos \varphi$, which is much smaller than the Mach number M_1 of the incident flow. In Fig. 33, the curve for P_1/P_2 can likewise apply to oblique shocks if in the abscissa the value $M_1 \cos \beta$ is plotted in place of M_1. For example, oblique shock waves may be produced by a cone the angle of which, 2 β, determines together with the incident Mach number the angle β of the plane of the shock wave.

These considerations enable us to make direct conclusions as to an appropriate intake configuration. The reduction of high incident speeds must transpire in several stages, as Oswatitch has previously proposed. The intake illustrated in Fig. 34 represents a reduction in three stages. The incident flow speed, M_1, is reduced to M_2 by the oblique shock wave originating from the cone's vertex. This is followed by another reduction without loss to M_3, subsequently reduced by a perpendicular shock wave to M_4, thus to subsonic speed. The losses at the two shock-wave planes, meanwhile, are influenced by the magnitude of the cone's angle 2 β. In the case of smaller angles, the losses are small in the oblique shock-wave plane and large in the straight shock-wave plane; in the case of larger angles, this process is reversed. It is clear, therefore, that with respect to smallest losses, there must exist an optimum cone angle for each incident flow speed M_1. The total pressure ratio P_4/P_3, which therefore contains the summation of the losses, is plotted in Fig. 35 against the half-cone angle for the straight shock wave without cone effect, and the gain achieved through the cone can be readily ascertained by comparison with the optimum value. For example, at a Mach number of $M_1 = 2.07$ the total pressure ratio P_4/P_1 of 0.69 is raised to 0.91 with a cone of $\beta = 27$ deg. The gain is, therefore, considerable. Moreover, it can be seen that, at Mach numbers up to $M_1 = 1.9$, the total pressure continues to remain above 95 percent, and that the optimum values of β are

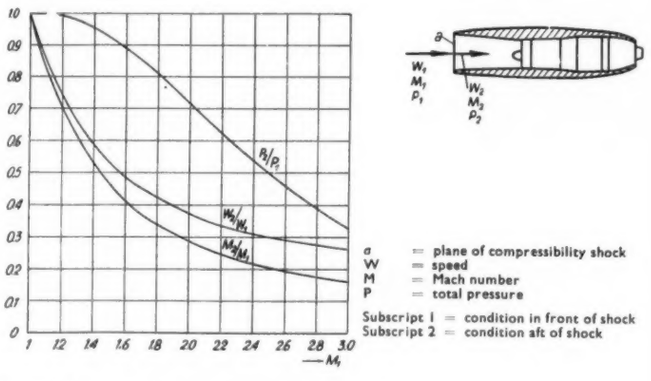


Fig. 33 : Perpendicular compressibility shock.

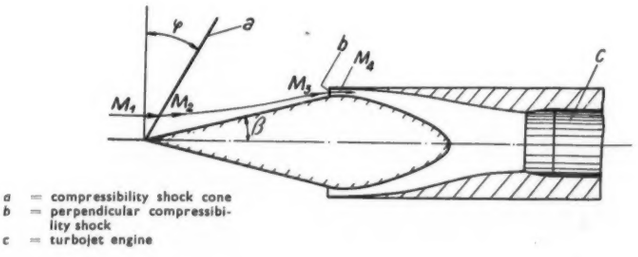


Fig. 34 : Intake configuration for supersonic flight.

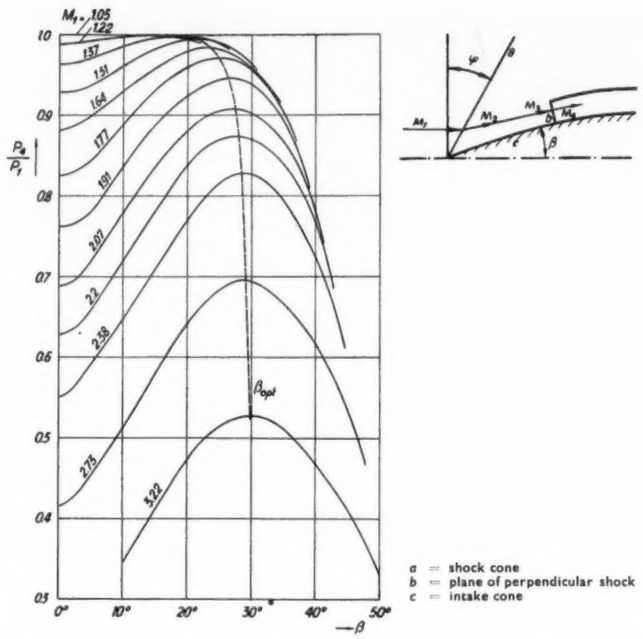


Fig. 35 : Compressibility shock losses for supersonic intakes Optimum cone angles.

below 30 deg. Above $M_1 = 2$, nevertheless, the losses augment rapidly, and it is necessary to have the oblique shock waves effect the speed reduction through a greater number of stages.

The optimum cone angles ascertained here are solely for obtaining the smallest possible intake loss. When taking the entire aircraft into account it must be borne in mind that an excess of pressure has arisen at the surface of the cone, which evidences itself as drag. In view of this fact, the optimum values of 2β shown in Fig. 35 will be somewhat less for the entire aircraft.

It must be emphasized again that the afore-mentioned considerations refer to frictionless flow conditions. The boundary layer will have a considerable influence, notably at the second shock wave, when strong tendencies to break away will be evidenced. Boundary-layer suction in the vicinity of the shock will also be necessary here. However, there will be no danger of break-away at the intake cone *c* between the two shocks, since at the first, oblique shock wave originating from the vertex there is no upstream boundary layer which could break away, and because the pressure is constant further aft on the surface of the cone.

PHOTO CREDITS :

Front cover and pp. 26-33; 36-45 : U.S. Department of Defense ; pp. 16-25 : U.S. Department of Defense (29), Manufacturers (19), ATP-Bilderdienst (2), Carswell AFB (2), Interavia (2), pp. 34-35 : USAF Air Materiel Command, pp. 46-48 : Civil Aeronautics Board (1), Scholer Bangs (1), Trans-Canada Air-Lines (1), PAA (1), p. 49 : "Esso Air World" (1), Interavia (1), pp. 50-53 : Hunting Aerosurveys (5), Air Survey Co. (1), RAF (3), RCAF (1); p. 54 : KLM; p. 57 : Manufacturers; pp 58-59 : Manufacturers (9), U.S. Department of Defense (1), Airmondial (1); pp. 62-65 : Author; pp. 66-74 : Manufacturers; pp. 75-79 : Levy-Shipp (2), Harold G. Martin (1), SBAC (1), Manufacturers (8) ; pp. 80-81 : Author ; pp. 82-85 : Author.

For your 1949 (Vol. IV) issues of
INTERAVIA REVIEW

our

Binding Covers

Imitation leather with gold lettering

are now available

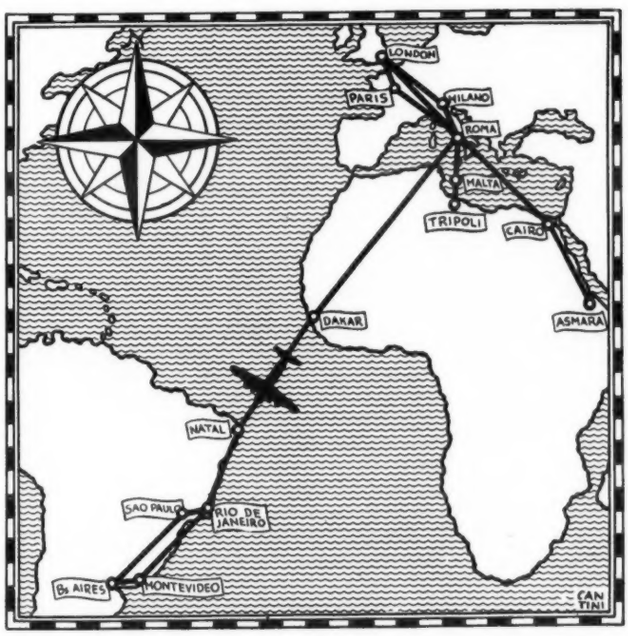
Price, including postage and packing:
Switzerland: Sw. frs. 6.50. Foreign countries: Sw. frs. 7.50

INTERAVIA S.A.
6, CORRATERIE GENEVA SWITZERLAND
Swiss postal cheque account No. I. 5380 Geneva

ALITALIA

Regular Air Services **Passengers Mail Freight**

Reservations and Information : PASSENGERS :
Rome : ALITALIA Office, 13 Via Bissolati, Rome. Phone: 470 241. Telegrams : ALIPASS - ROME
Milan : ALITALIA Office, 1, Via Manzoni, Milan. Phone : 12 626. Telegrams: ALIPASS-MILAN
FREIGHT :
Rome : ALITALIA Office, 44 Via San Basilio, Rome. Phone: 471 694. Telegr.: ALIMERCI-ROME



when it's a question of **REMOTE CONTROL**

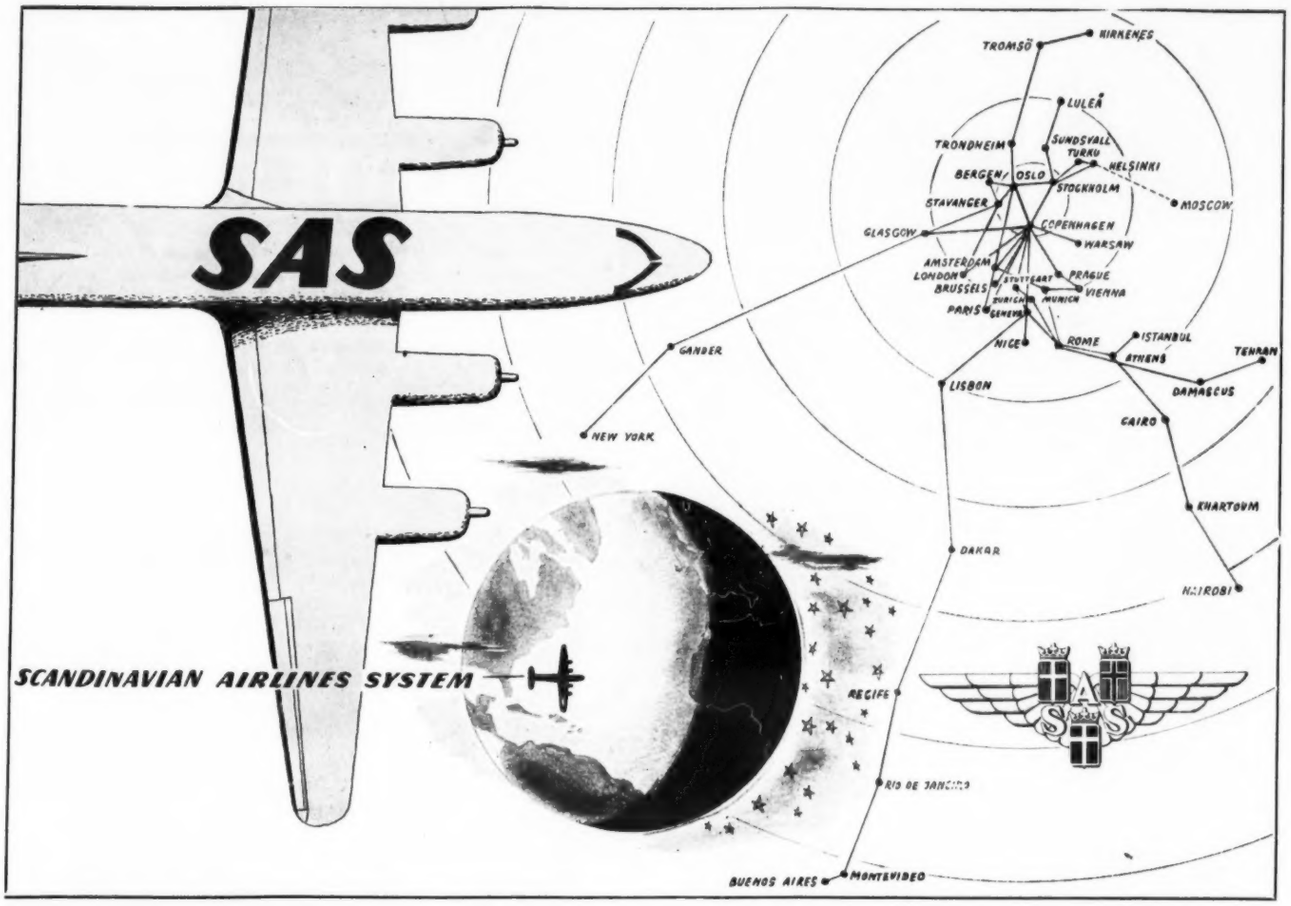
DUNLOP has the answer

The instantaneous and easy operation of pneumatic actuating equipment raises problems to which the unique Dunlop Electromatic Valves are the perfect answer. Designed both to provide instantaneous selector-operation and reduce cockpit piping, the valves are especially successful for thermostatic engine control where they operate pneumatic jacks coupled to cooling air shutters. By suitable grouping of solenoids, they can be used for many types of pneumatic selection in remote control systems. Valves have been designed for one to eight-way actuation. They are standard equipment on Rolls-Royce Griffons and Merlins in Shackleton and Tudor power plants.

Dunlop technicians are always available for consultation with designers or constructors on new applications for Electromatic Valves.

Dunlop serves THE AIRCRAFT INDUSTRY

DUNLOP RUBBER CO LTD (AVIATION DIVISION) FOLESHILL COVENTRY ENGLAND



SOCIÉTÉ NATIONALE D'ÉTUDE ET DE CONSTRUCTION DE MOTEURS D'AVIATION

150, Boulevard Haussmann - PARIS (8e)

PYE LIMITED of Cambridge, England, are Manufacturers of I.L.S. (Beam approach) equipment, approved by I.C.A.O. and marketed by Marconi's Wireless Telegraph Co. Ltd., throughout the world.

PYE
Telecommunications
CAMBRIDGE ENGLAND

PYE LTD • TELECOMMUNICATIONS DIVISION • CAMBRIDGE • ENGLAND

ALI FLOTTE RIUNITE

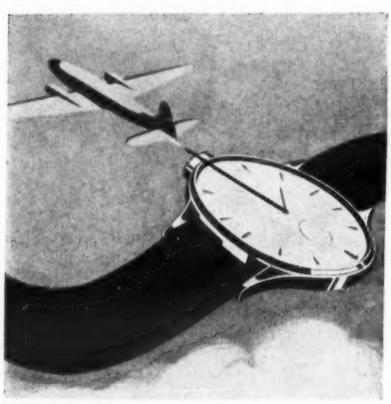
Domestic air network linking the major centres of Italy.
International air network linking Italy with Western Europe, Central Europe and the Middle East.

Information and reservations :
Rome, Aerostazione ALI, Via Barberini 113, tel. 470 851 - **Milan,** Agenzia ALI, Via Caserotte 5, tel. 17 656 - **Venice,** Agenzia ALI, Ascensione 71 b, tel. 20 271 - **Cagliari,** Agenzia ALI, Via Roma 81, tel. 31 64 - **Torino,** Agenzia ALI, Via Gobetti 10, tel. 40 684

Sphinxworks Muller & Co. Ltd.

Precision machine cut screws & turned parts
Small drills and taps

Soleure (SWITZERLAND)



"IBERIA's" AIRLINERS RUN WITH THE PRECISION OF A SWISS WATCH

From Madrid to :

Buenos Aires, Caracas, Puerto Rico, Habana, Mexico City, Paris, London, Geneva, Rome, Lisbon, Canary Islands, Tangiers, Spanish Morocco and all major points in Spain.

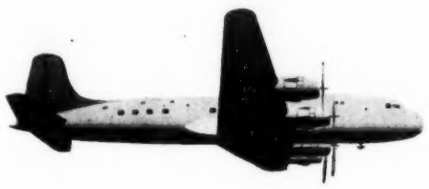
BOUGIES
RAMPES
MAGNÉTOS
RÉGULATEUR D'AVANCE
VIBREURS

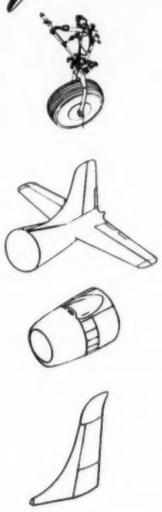
ABG

DÉPARTEMENT AVIATION
3 IMP THORETON - PARIS XV - VAU 68 40

OCERP

Quality calls for *Quality*





The reliability of Douglas aircraft is unequalled. Every day, thousands of Douglas planes in service on the airlines of the world prove this fact anew.

But quality of *detail*—the origin of this reliability—will suffer unless two conditions are scrupulously met :

1 - regular, thorough maintenance

2 - replacement, in due time, of worn parts with spares of identical quality (which can only mean : with Warranted Douglas Spares*).

For over two years now, Douglas service has been available in Europe to help you fulfil these conditions, essential to the efficient operation and to the reputation of your airline. Douglas European Division in Brussels offers rapid delivery of spare parts and assemblies to operators in Europe, Africa and the Middle East. By ordering from the European Division, you ensure receiving factory-new, Warranted Douglas Spares. And don't forget : Douglas engineers and specialists are at your service when you need help with technical and operational problems.

** A 10% reduction on the price of all Warranted Douglas Spares has been in force since July 5th.*

DOUGLAS

DOUGLAS AIRCRAFT COMPANY, INC.

European Division

1470, Chaussée de Hæcht, Aérodrome de Haren, Brussels, Belgium
Cables : Douglasair-Brussels. Telephone : Brussels 16.06.45

DC-3, VICKERS VIKING, C-54 TYPES AND

DC-4 OVERHAUL

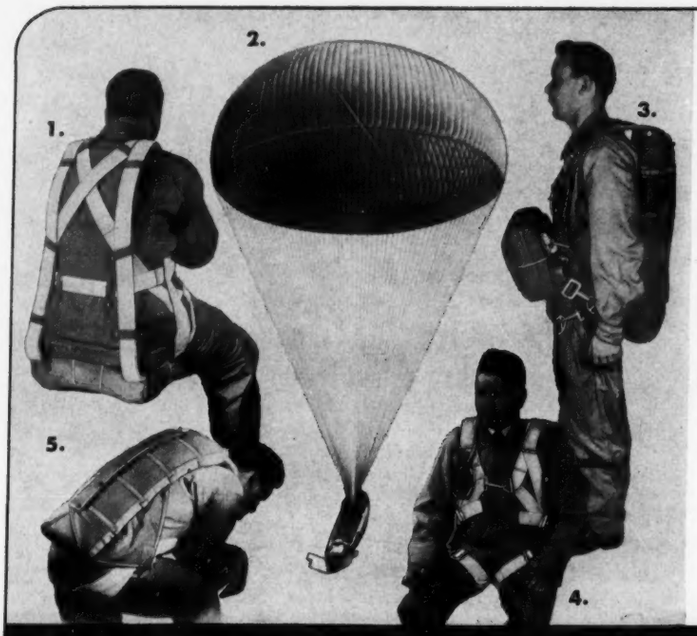
DANISH AIR LINES has now taken over their new modern overhaul hangar with adjacent workshops furnished with a complete system of tooling and testing-equipment.

DANISH AIR LINES is now capable of doing practically every phase of aircraft maintenance work for YOU, *including complete stripping and resealing with EC-801.* We offer our services on the standard contractural basis existing in the airline industry.

DANISH AIR LINES will be most happy to consult with Aircraft Operators in solving their problems of overhaul, and a qualified specialist is available for consultation at your base.

DDL

DANISH AIR LINES, TECHNICAL SALES AND SERVICE, KASTRUP AIRPORT



There's a PIONEER PARACHUTE

For every plane
For every purpose

1. **AN-SS Military Model Seat Type Parachute**—standard equipment for the Air Forces of the U.S. Army and Navy and other governments.
2. **Pioneer maintains a special department for the manufacturing of Cargo and Air-Sea Rescue parachutes** in sizes ranging from 8 ft. to 150 ft. in diameter.
3. **P-T-30 Training Parachute**—flexible back-pack with quick-attachable auxiliary chest pack, both packs on single Quick-Fit Harness.*
4. **All Pioneer Parachutes are equipped with the exclusive Quick-Fit Harness***. Perfect fit in less than 3 seconds.
5. **Flexible P-3B Back-Pack Parachute**—standard equipment for the U.S. Air Forces and other governments, test pilots, leading aircraft manufacturers.

*PATENTS APPLIED FOR IN U.S. AND ALL PRINCIPAL COUNTRIES THROUGHOUT THE WORLD

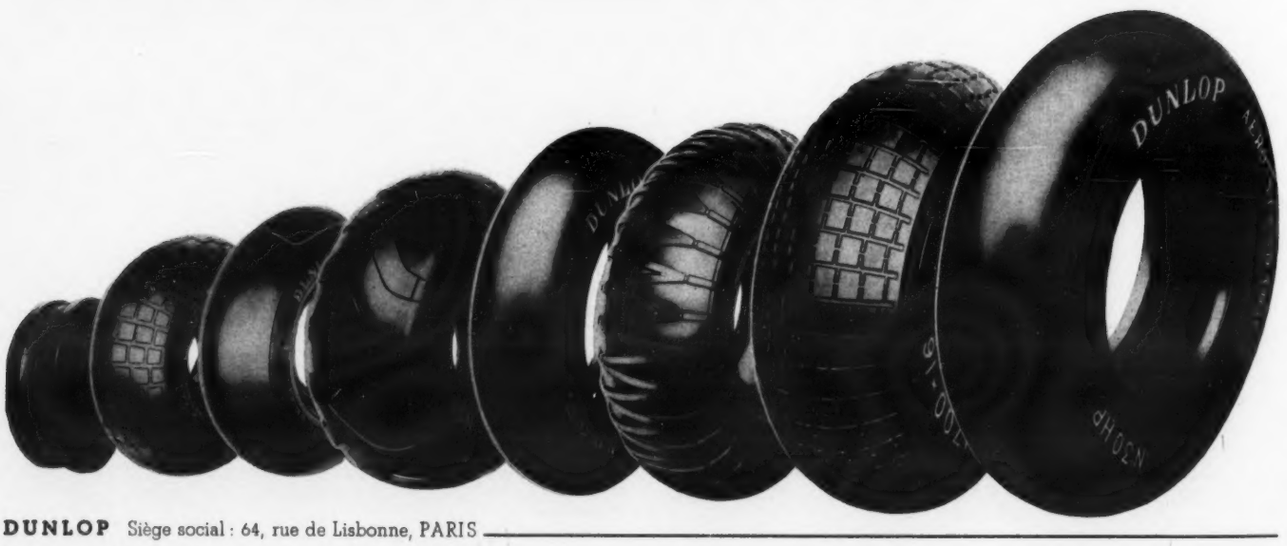
PIONEER PARACHUTE COMPANY, Inc.

MANCHESTER, CONNECTICUT, U. S. A. CABLE ADDRESS: PIPAR

Switzerland	WOTHOM S.à.r.l. Witikonerstrasse 80, Zurich 32, Switzerland
Holland, Belgium and Denmark	SCHREINER & Co. 24 Javastraat, Den Haag, Holland
France	GUY ROBERT Equipements d'Avions et d'Aérodromes, 11 Rue Tronchet, Paris 8, France
Turkey	AFFAN ATACERI, 68 Adakale Sokak, Yenisehir, Ankara, Turkey
Sweden, Norway and Finland	AKE FORSMARK, Kummelvagen 9, Alsten, Stockholm, Sweden

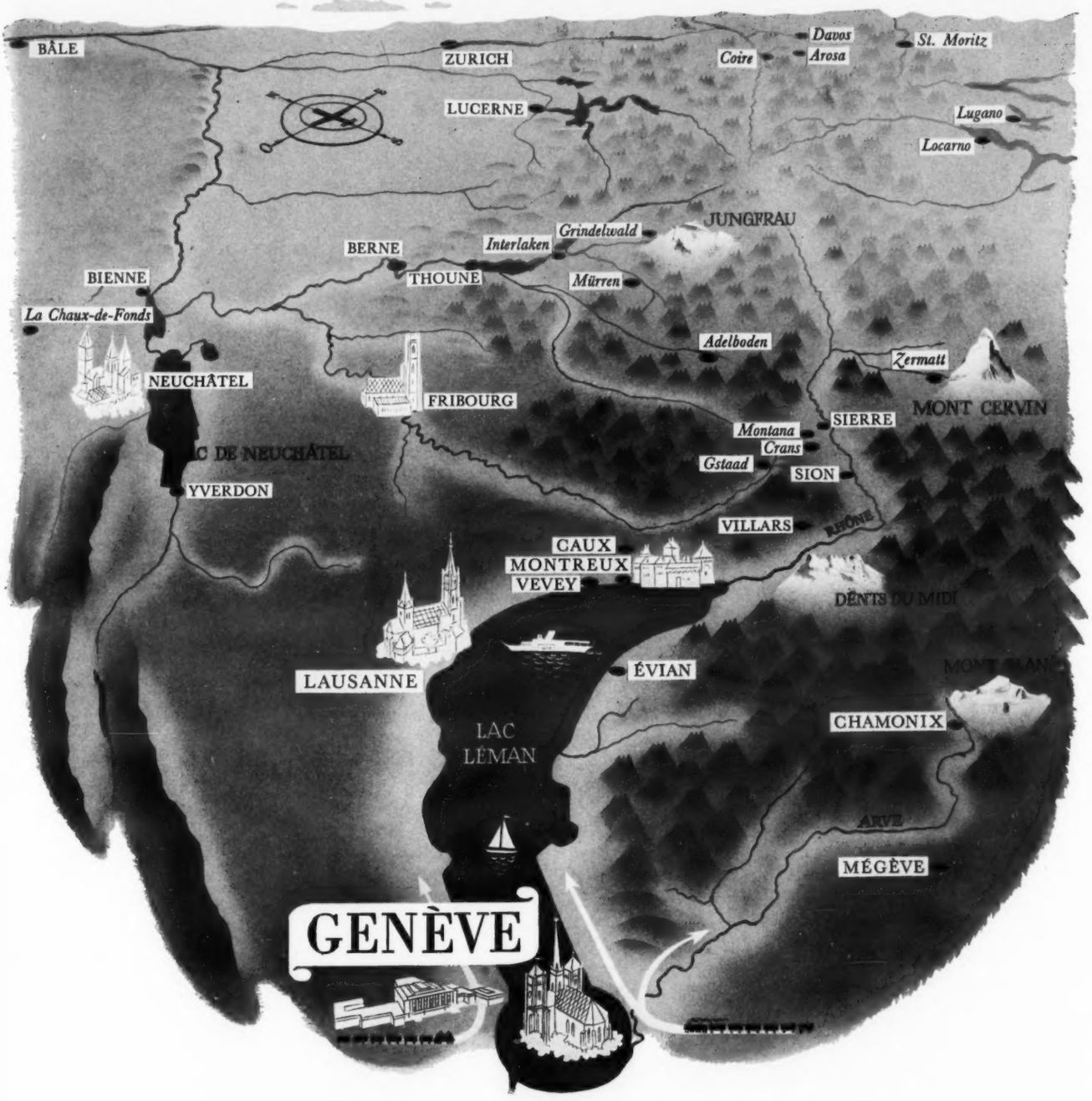
DUNLOP

PNEUS DE SECURITÉ POUR AVIONS

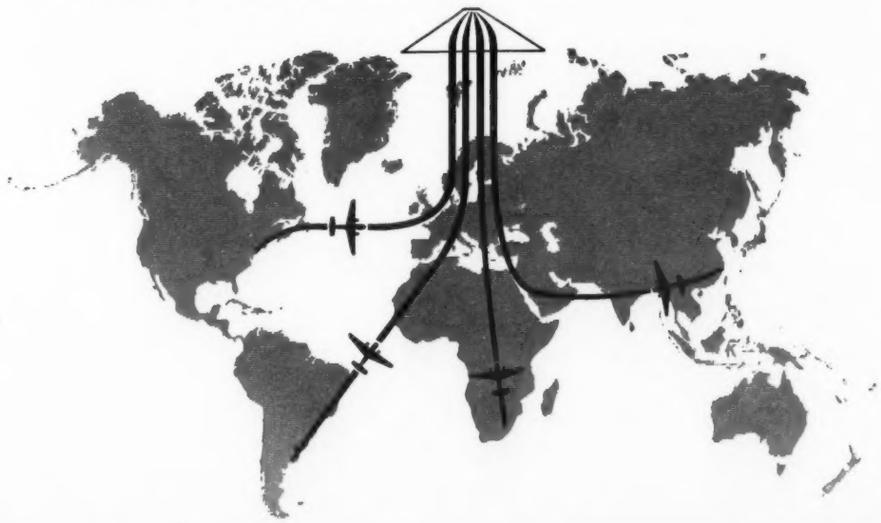


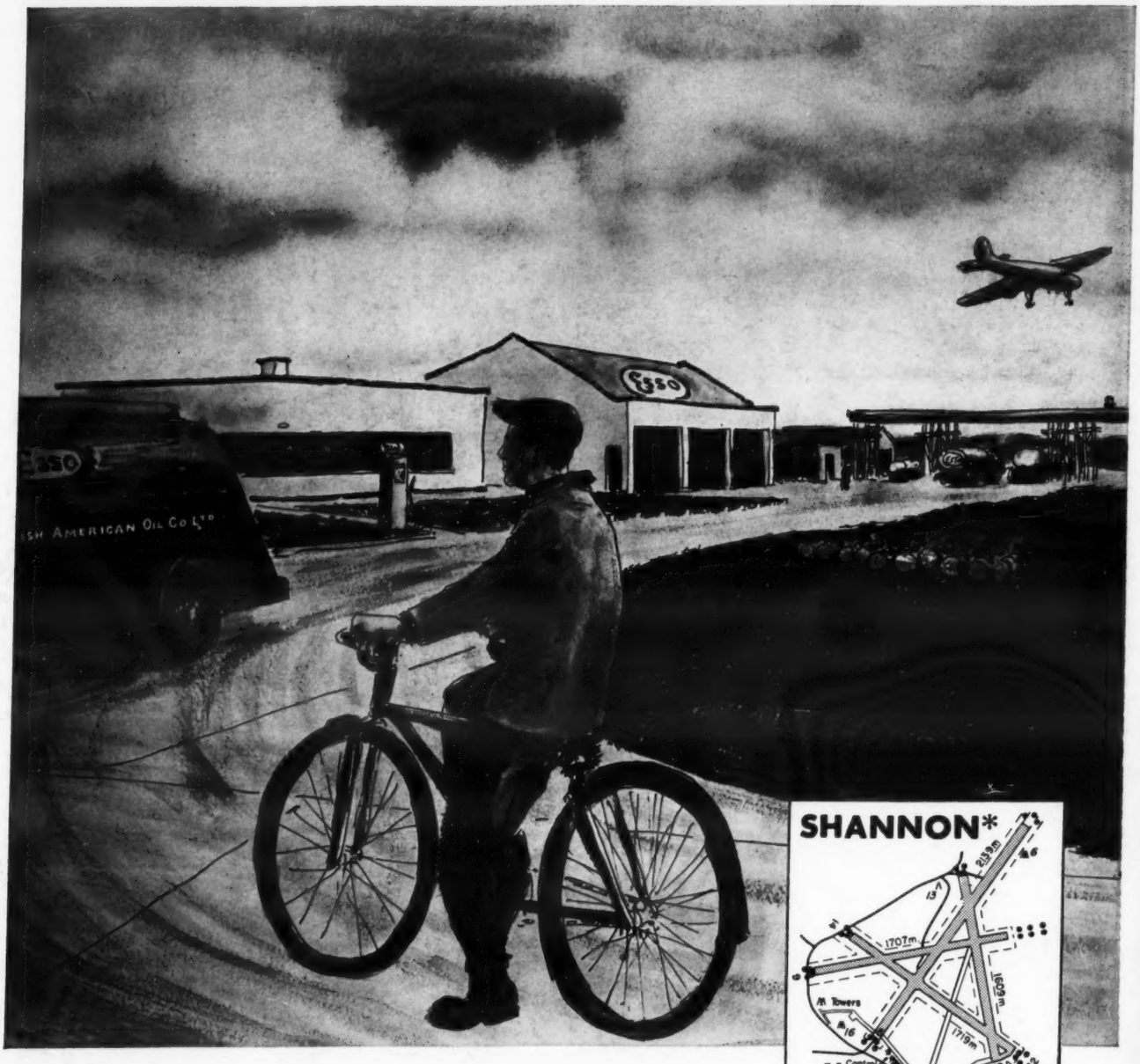
DUNLOP Siège social : 64, rue de Lisbonne, PARIS

Printed in Switzerland



Geneva, International Aviation Centre





A Good Sign to Fly to...

Esso

AVIATION PRODUCTS

One of the largest and most important airports along the North Atlantic air route is Shannon, located near Limerick in Ireland. As a natural stop for refueling flights to and from North America it is one of the many major fields along the airways of the world where Esso Aviation Products and service are available. Research and development constantly improve these to meet aviation's demands for dependability and high quality. The Esso winged oval is the symbol of products of uniform, controlled quality backed by more than 40 years of aviation experience.

**At Shannon Airport and throughout Ireland, the marketer of Esso Aviation Products is Irish American Oil Company, Ltd.*

ESSO EXPORT CORPORATION, AVIATION DEPARTMENT, 25 BROAD STREET, NEW YORK 4, N.Y.